Journal of the Royal Society of Arts

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INAUGURAL MEETING OF THE 208TH SESSION

The Inaugural Meeting of the 208th Session will take place on Wednesday, 1st November, at 2.30 p.m. After his Inaugural Address (the title of which will be announced in the next *Journal*), the Chairman of Council, Lord Nathan, will present silver medals awarded for papers read during the last session, together with other awards, and thereafter tea will be served in the Library. The Chairman and Members of Council particularly hope that they may have the pleasure of meeting Fellows of the Society personally on this occasion.

LUNCHEON IN MANCHESTER

It was announced in the Annual Report that a programme of activities organized by Fellows living in the North-Western area of the United Kingdom was under consideration. The inaugural function, a luncheon meeting, has now been arranged to take place at the Grand Hotel, Aytoun Street, Manchester, on 27th November, to coincide with a visit which the Chairman of Council, Lord Nathan, is paying to the city. The luncheon (at 1.10 p.m.) will be preceded by an informal reception from 12.45 p.m., and it will be followed at approximately 2 o'clock by an address entitled 'Some Reflections on Crime and Punishment' by Dr. Dennis Chapman of Liverpool University. The whole proceedings will terminate by about 2.45 p.m.

Invitations to attend are being sent direct to Fellows living in the North-Western area, but the meeting is open to all Fellows of the Society, who may each bring one guest. The cost of the meeting and luncheon will be £1 1s. for each person, exclusive of wines. Applications for tickets, together with the appropriate remittances, should be sent to Mr. A. C. Sewter, 5 Nursery Avenue, Hale, Cheshire.

TEMPORARY CLOSURE OF THE LIBRARY

On the 4th and 5th October the Library will be used in connection with an International Design Congress which has been arranged at the Society's House by

the Council of Industrial Design. It is regretted therefore that on those two days it will not be possible for Fellows to use the room or borrow books (except by post) from the collection. The Fellows' Parlour will be available as usual.

RABINDRANATH TAGORE CENTENARY: UNVEILING OF A MEMORIAL PLAQUE

Fellows will remember that this summer the Society collaborated with the Royal India, Pakistan and Ceylon Society, the East India Association and the Royal Commonwealth Society in arranging a number of activities to commemorate the centenary of the birth of Rabindranath Tagore, the Indian poet and writer. The final event of these celebrations will be the unveiling of a memorial plaque to Tagore at No. 3 Villas on the Heath, Vale of Health, Hampstead, the house where he stayed in 1912. The plaque has been affixed by the London County Council as the result of a joint request made by the four Societies earlier this year. A short public ceremony will be held outside the house at 11 a.m. on Thursday, 19th October. The act of unveiling will be performed by Lord Spens, President of the East India Association, in the presence of representatives of this Society and the other interested bodies.

It may be recalled that the practice of fixing commemorative tablets to London houses was originated in 1867 by the Society of Arts, which continued the work until, by agreement, it became the responsibility of the London County Council in 1901. In honouring Tagore the Society is also happy to renew, in this way, its association with the custom.

THE SOCIETY'S CHRISTMAS CARD

An order form for the Society's Christmas Card, including an illustration and description of the subject, and full details of prices, is included at the back of this issue of the *Journal*. Orders are now being fulfilled, and Fellows who intend but have not yet arranged to purchase cards are requested to complete and return the form without delay.

INDUSTRIAL ART BURSARIES EXHIBITION

The exhibition of winning and commended designs submitted in the 1960 Industrial Art Bursaries Competition will be on view at the Bradford City Art Gallery and Museum, Cartwright Memorial Hall, Bradford 9, from 2nd to 13th October, and at the Middlesbrough College of Art, Green Lane, Linthorpe, Middlesbrough, from 23rd October to 3rd November.

TECHNICAL ADVANCES IN PACKAGING

A paper by

V. G. W. HARRISON, Ph.D.,

Director, Printing, Packaging and Allied Trades Research Association, read to the Society on 3rd May, 1961, with Milner Gray, R.D.I., PP.S.I.A., a Member of Council of the Society, in the Chair

THE CHAIRMAN: Most people with any close connection with packaging will know of the invaluable work undertaken by PATRA, the Printing, Packaging and Allied Trades Research Association, in the study of technical packaging and especially of packaging in the course of transit. Those without such packaging connections may be the more surprised to learn what it takes to ensure the safe delivery of packaged goods. Dr. Harrison, whom I am delighted to welcome as our speaker tonight, has been with PATRA for twenty-four years and became Director of Research in April, 1957, and there is no one better equipped than he to tell us about these things.

Although he is speaking to us tonight on the subject of technical packaging, his work in the scientific field has embraced a wide range of activities. He has made a special study of half-tone reproduction and colour and opacity measurement. He has played a prominent part in the development of colour and opacity measuring instruments. The EEL spectro-photometer and the PATRA-Hilger opacimeter were made according to his specification. He has helped in the development of Victor Letouzey's electronic colour measuring instrument, the chromameter, and he has translated into English Letouzey's book, *Colour and Colour Measurement in the Graphic Industries*.

Dr. Harrison has also concerned himself with the study of paper directed primarily at the measurement of opacity. He was responsible for the opacity measuring specifications laid down by the Technical Section of the British Paper and Board Maker's Association. During the war years he was attached to the Ministry of Supply, dividing his time between PATRA research projects and Government work. At the Ministry he was mainly concerned with paper problems and with studying the transmission of moisture through waxed paper and similar materials. He also worked on the testing of cartons used for war supplies. He is a Fellow of the Institute of Physics, of the Royal Photographic Society, the Illuminating Engineering Society, the Physical Society, as well as of the Royal Society of Arts. He is also a member of the Institute of Packaging and the Optical Society of America. In association with Dr. G. W. Scott-Blair and Dr. H. R. Lang, he founded the British Society of Rheology.

It is one of the privileges of Members of Council of the Royal Society of Arts to be asked to take the Chair at meetings of the Society, and I am particularly flattered to be asked to do so to-day, the more especially as I am told that the invitation to Dr. Harrison developed to some extent from a very general paper on 'Packaging Progress' which I myself read in April, 1959, and in which I touched briefly on the important technical advances which have been made in recent years into methods of packaging. We are fortunate indeed to have with us so knowledgeable a man as Dr. Harrison to tell us more about this work.

The following paper, which was illustrated with lantern slides, was then read.

THE PAPER

Twenty-five years ago the word 'packaging' was rarely heard. Packaging as a subject—almost an independent industry in its own right—sprang up during the war and immediate post-war years in direct response to an evident need. During the early war years, a terrifyingly high percentage of the food and supplies intended for our troops stationed abroad, notably in the Middle East, was found on arrival to be useless through inadequate protection from climatic or transit hazards. Badly-needed spares for aircraft or tanks were unloaded by eager crews only to find that they were valueless because of corrosion, rusting or mechanical fracture. Our struggles for survival thus made an intensive study of packaging problems imperative, and many of the lessons learnt at so high a cost during those critical years are applied with good effect to-day. The post-war years have seen, moreover, the appearance of numerous self-service stores and supermarkets, which in their turn are a direct result of the post-war shortage of labour. In such stores the only salesman is the package itself, and therefore the sales appeal and general design of the packages become of paramount importance.

Packaging, strictly speaking, is not an industry. It is a part of many industries, and the design of the packages destined to carry the finished goods should be regarded as an integral part of the whole production process, being the final link in a long chain which probably started with the engineer's drawing board. Packaging should not be regarded as an afterthought—something to be dealt with as quickly and cheaply as possible once the finished goods are ready to leave the factory.

I have already mentioned the two main functions of packaging: first, to provide protection to the goods enclosed; second, to enhance the sales appeal of the goods. This second function is one about which I am not particularly qualified to speak, and in any case it has been dealt with very adequately by our Chairman in a paper read to this Society in 1959. In this paper, Mr. Gray deals with the important problems of visual appeal, brand image and other means whereby a customer is induced to buy one brand of goods rather than another. The packaging expert in this field has not only to be a first-rate designer, he has also to know something of psychology; and indeed motivational psychology is widely used in the U.S.A. and to a less extent in this country. I shall, however, have to leave these very important and interesting problems on one side this evening.

The technical advances in packaging which I shall try to describe will, therefore, be concerned solely with the other function of packaging, namely, to provide adequate protection to the goods enclosed. It may be necessary to afford protection against a number of hazards, either severally or in combination. The most important of these are: mechanical shock of various types arising in transit; climatic hazards; attacks by insects, moulds and bacteria; harmful effects of light and radiation; and finally, in the case of foodstuffs, premature putrefaction. All this brings us to the first great difficulty of packaging, namely, that almost every package has to be 'tailormade' to suit the goods to be transported and the particular journey over which they are to be sent. The parts of the goods susceptible to damage from these causes have to be identified; the nature and probable intensity of the hazards to

which the package will be subjected during its journey have to be assessed; and finally, a pack has to be designed capable of giving adequate protection to the goods without being unduly expensive. This brings me to the second difficulty.

It is, of course, possible to design a package capable of giving protection against almost any conceivable combination of hazards, provided that cost is no object. In most cases, however, cost is very much an object. With delicate scientific equipment, intended perhaps for a medical school abroad where lives may depend upon an instrument's arriving intact, the cost of the package may indeed be a minor consideration and almost every protective device can be incorporated. With breakfast foods, on the other hand, the cost of the package may be as much as the cost of the foodstuffs; and a fraction of a penny more or less spent on the package may make all the difference between profit and loss. It is, therefore, essential in these cases to make sure that the package does its work adequately, but no more, at a minimum cost. This sounds obvious, but the earlier packagers had very little previous experience to guide them and had to work largely in the dark. Research, aided by somewhat costly trial and error, is now providing a more reliable guide.

In designing a package, therefore, it becomes essential at an early stage to distinguish between those hazards which must be regarded as normal for the journey which the package will have to undergo and against which the package must provide adequate protection, and those hazards which are abnormal and which can be left to be covered by insurance. A package may conceivably drop from a flying aircraft, but no package would normally be required to cope with such a hazard. On the other hand, it is now well established that drops of two feet and less are common in goods conveyed by road or rail transport, and the package must therefore be capable of ensuring that the goods enclosed are adequately protected against a number of such shocks.

Research into these hazards is therefore in progress both in this country and elsewhere. Its object is first to establish what are the normal hazards—mechanical, climatic or otherwise—which the package may be expected to experience in its journey; and secondly, to set up laboratory test sequences so that these hazards may be simulated in the laboratory for the purpose of testing one type of protective device against another.

JOURNEY HAZARDS

By 'journey hazards' we generally understand those mechanical stresses to which the packaged goods are subjected during their normal conveyance from one place to another. These stresses may be static, as in crushing due to excessive stacking, or they may be transient, as in drops, bumps, and vibration of various types.

Much of the damage to packages occurs through drops from various heights, either on to the flat faces or on to the corners of cartons, or even worse, on to vulnerable parts projecting from the main body of the pack. Although some of the damage occurs during carriage by road or rail, most of it takes place when the goods are unloaded at terminal or interchange points. The size and the weight of the package determine to a large extent whether it is likely to be thrown about or handled more carefully. Scientific study of these hazards has been in progress for several years now, both in Great Britain, Sweden and Germany, and a general pattern is

beginning to emerge. Broadly speaking, there are three possible ways of investigation. The first is by direct observation; that is, by placing observers at strategic points on the route and instructing them to note the method of handling and the heights and frequency of drops. This method has the advantage of being direct and costing little in the way of apparatus. On the other hand, the severity of the drops is difficult to estimate visually and the mere presence of an observer may cause the packages to be handled rather more carefully than would normally be the case, particularly when the heavier packages are being moved. It is, therefore, quite possible that some of the worst drops may be missed by the observer. For this reason, it may be advantageous to replace the observer by a ciné camera. This soon passes unnoticed by the operators, and subsequent frame by frame examination of the film will enable much more accurate estimates of the height of drop to be obtained than is possible by direct observation. This method is particularly valuable when the operators' movements tend to be repetitive, as for example in the loading and unloading of large consignments of similar materials on to moving belts, as takes place in some shunting yards. The third method of investigation, which is largely adopted in the PATRA laboratories, is to incorporate in the package some form of shock recorder which will indicate the frequency and intensity as well as the direction of the drops to which the pack has been subjected in its journey. In a later development of the apparatus, the time of impact can also be recorded. This method has many advantages, but it has the drawbacks of being costly and time-consuming. This is because of the nature of the hazards, which tend to be sporadic, so that large numbers of observations must be taken in order to get statistically meaningful results. The journey shock recorder which has been in use up to now in our experiments is shown in Figure 1. It consists of a framework with a drum counter at one end and at the other a flap held by a spring against a stop. When a frame receives a shock to the plane of the flap, the flap tends to move down against the spring tension; if the shock is large enough, the flap moves and engages the counter. The intensity of the shock required to operate this counter is governed by the tension of the spring, so that the recorders can be set to operate for any desired drop heights. In practice, we normally set them to 6 in., 1 ft., 2 ft. and 3 ft., or to 6 in., 12 in., 18 in. and 24 in. In order to eliminate chattering of the flap, the whole mechanism is immersed in a damping fluid.

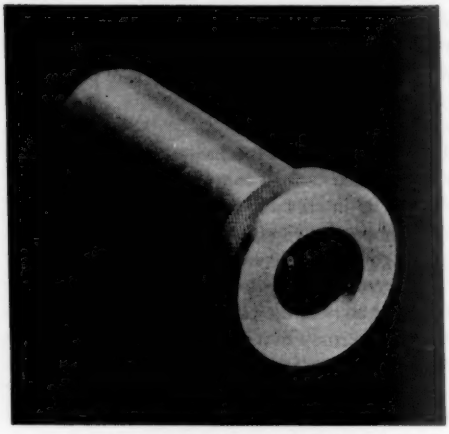

FIGURE 1. PATRA *journey shock recorder*

A single counter gives very limited information; for this reason, counters are normally

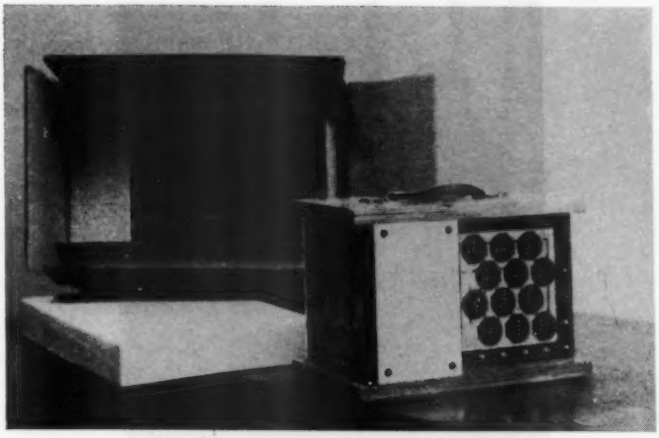

FIGURE 2. *Block of shock recorders, showing method of cushioning in outer case*

mounted in banks of twelve in a block of wood. The use of such an assembly enables estimates of four different drop heights to be obtained in each of the three principal planes of the package. The block and its counters are not, of course, sent out naked; they are enclosed in an innocent looking carton, containing cushioning material of foamed polyurethane (Figure 2). The function of this cushioning material is to make the shock received by the counter essentially independent of the compressibility of the ground (that is, the type of ground on which the package falls, whether soft earth or concrete, etc.), and secondly, to make the shock less dependent upon the angle of impact of the case with the ground.

In practice, numbers of these packages containing shock recorders have been sent by a round route in co-operation with the British Transport Commission, which has also made a substantial grant towards the cost of this research. At each terminal point each case was opened and the numbers on the shock recorders noted by an observer; the packs were then resealed and sent on the next leg of the journey.

One of the big difficulties with this work is the variability of the hazards experienced, because one consignment of these recorders may record severe damage on a journey from Leatherhead to London but those sent on the same route the next day may suffer no ill-treatment at all. It is for this reason that large numbers of such experiments must be carried out over a period of time. The work is not cheap to do; the recorders are not inexpensive in the quantities required, and the freight charges alone amount to a substantial item.

The results given by these various techniques were discussed and compared

FIGURE 3. *Drop test*

at an International Conference of Packaging Research Institutes held in Leatherhead in May, 1960. The findings of the various national laboratories were encouragingly concordant, and the proceedings of the Conference are to be published. I need indicate only the general trends here. Most of the drops occur at terminals or interchange points as, for example, when goods are unloaded from a van on to a porter's trolley or moving band. Drops of three feet and over are uncommon; on the other hand, drops of less than two feet are frequent, the majority being in the six inches to twelve inches range. It certainly seems from this that a package should be capable of protecting its contents from the effects of a direct drop of up to three feet. Drops of more than this may have to be regarded as insurance hazards. Labels such as THIS SIDE UP have an appreciable effect in keeping packages on their bases but, more important, the side bearing the name and address to which the goods are to be sent tends to be kept uppermost so that it can easily be read. When this is so, about three-quarters of the drops tend to be on the base of the container. The size, shape and weight of the pack will also govern the sort of treatment it is likely to receive. Those which are handled the worst are those which

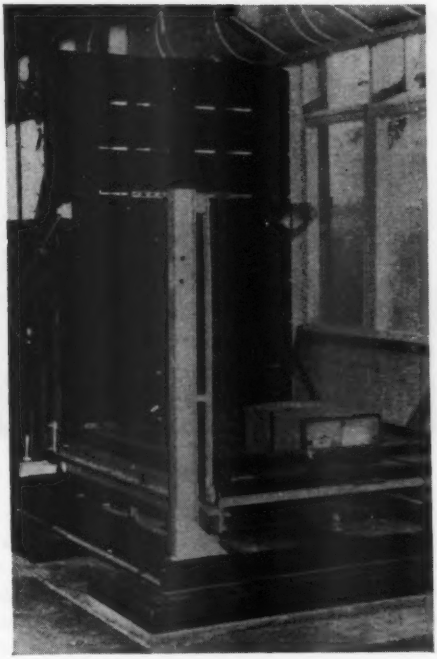

FIGURE 4. LAB *vibration tester*

one man is capable of lifting with a certain amount of difficulty. He is thus tempted to drop or throw the container, and the critical height of three feet established in our experiments corresponds roughly to the height of the tailboard of a lorry or waist height. On the other hand, heavier packages which must be handled by two or more men, with or without mechanical aid, generally receive more careful treatment.

Package testing laboratories generally make use of the drop test for assessing the suitability of a package to withstand mechanical hazards of the nature just described. The package to be tested is hoisted by means of a rope and pulley, fitted with a quick release gear, to a determined height above a metal plate sunk in concrete (Figure 3). The height of drop is checked by means of a scale and the load is released. Generally, the package is subjected to a test sequence whereby it is dropped in turn on to the various faces, edges and corners from one or more heights. The exact sequence chosen depends upon the severity of the tests required and this, in turn, depends on the length and severity of the journey which the package is required to undergo.

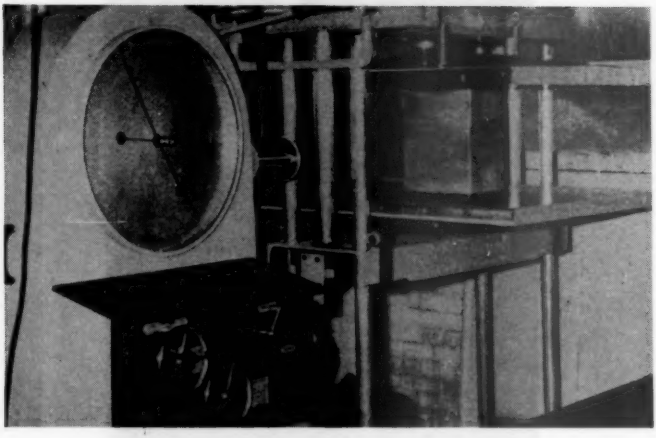

FIGURE 5. *Crush test*

There are, of course, other mechanical hazards. There is vibration. The effects of low-frequency vibration are simulated in the LAB vibration tester illustrated in Figure 4. The frequency of vibration may be adjusted within limits, and the platform moves with a combined sideways and up-and-down movement so that any point on it moves in a circular path. The goods may be fixed to the platform or may be left to 'float' on it when a certain frequency is reached. Experience has shown that a period of test of about half-an-hour on this machine simulates the sort of damage likely to be experienced when goods are transported long journeys by railway. On the other hand, the type of vibration experienced in aircraft journeys is of a much higher frequency, and a vibration tester constructed in accordance with the DEF 1234 Specification is used for this purpose.

If the goods to be transported are conveyed in an old truck having 'flats' on the axles or wheels, they may be subjected to periodic bumps. Bumps may be defined as small drops over a height not exceeding one inch, but at frequent intervals. The bump tester we use for simulating this type of hazard is also constructed in accordance with Specification DEF 1234.

When the goods are not actually on the move they may still be subjected to hazards, mainly those of stacking when loading or unloading, or in storage. Some stacking is of course accepted practice, but excessive stacking subjects the packages at the bottom of the pile to high stresses and collapse may result. The crush test shown in Figure 5 subjects the test pack to an increasing load stress, and the stress and strain are recorded automatically on a graph. From the data so obtained it is possible to calculate the probable safe stacking height of a given type of package.

FIGURE 6. *Drop hammer for research on cushioning materials*

CUSHIONING MATERIALS

Drops, bumps and vibrations subject the goods packaged to accelerations or decelerations which may rise rapidly to high values. These accelerations in turn induce stresses in the articles which, when they exceed certain critical values, cause breakage. A well-designed package will reduce the danger of breakage in two ways. First, by means of struts, tie bars, slats or other mechanical devices it will reduce the possibility of movement of the articles within the package, and hence their tendency to vibrate or chatter particularly at resonance frequencies. Secondly, the package will incorporate a layer of cushioning material, the function of which is to reduce substantially the peak values of the acceleration experienced by the articles, so that the stresses developed are correspondingly small.

The commonest of these cushioning materials is corrugated board. Other materials which have been investigated recently include foamed polyurethane, latex foam, closed-cell rubber, sponge rubber, cellular neoprene, open-celled p.v.c., packaging felt, rubberized hair, resin-bonded woodwool, and coir pads. In selecting suitable cushioning materials, not only the cost of the product and its cushioning

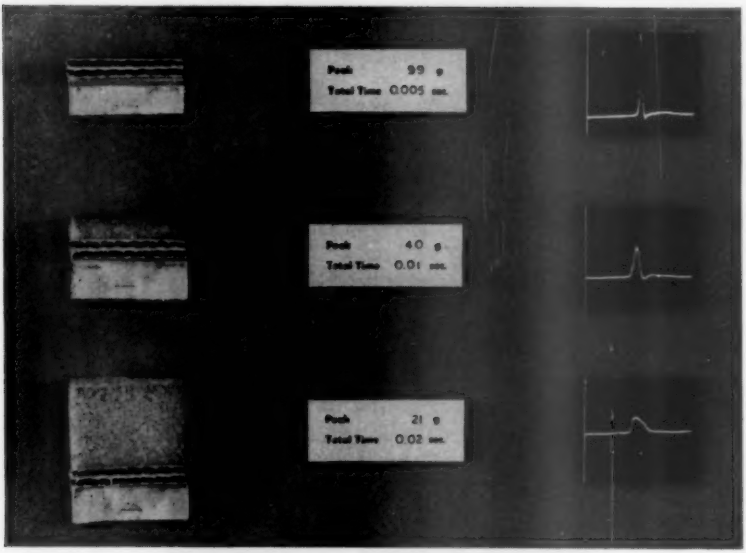

FIGURE 7. *Shock pulses for corrugated board plus sponge rubber. Shock is measured in 'g', the unit of gravitational acceleration. A wooden block dropped on to concrete from 6 in. receives a shock above 1,000 g*

properties have to be considered, but also the effect on these properties of temperature and storage over prolonged periods. The cushioning properties of materials are examined at PATRA House in the guided drop-hammer apparatus illustrated in Figure 6. The specimen to be tested is clamped on to a reinforced concrete base and the guided hammer is allowed to drop on it from various heights. The head of the hammer contains a crystal accelerometer connected to an oscillograph and enables records to be kept of acceleration and deformation of specimen against time. The sort of records obtained are illustrated in Figures 7 and 8. Figure 7 shows (top) the track obtained with corrugated board only; there is a very high peak acceleration and a rapid rise and fall towards this peak. This indicates that the stresses developed in the articles falling on this board are correspondingly high. The addition of about one cm. thickness of sponge rubber reduces this peak acceleration very considerably and broadens the curve at the base, showing that the development and extinction of the acceleration takes place over a greater length of time; in other words, the cushioning is greatly improved. Incorporation of a considerably greater amount of sponge rubber further reduces this peak acceleration, but it will be noted that the reduction is not in proportion to the quantity of material employed, so that it becomes more and more costly to produce further increases in the effectiveness of the cushioning. Once again, then, our problem is to decide

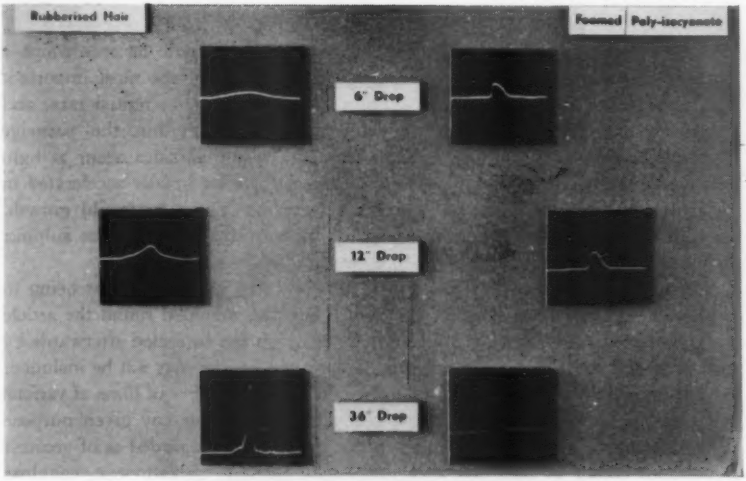

FIGURE 8. *Properties of cushioning materials. The shock received increases with the height of drop. The picture shows the shocks for two cushions: one gives greater cushioning for low drops, but is 'bottomed' when the drop height is increased; the other, less effective at low heights, maintains its cushioning at higher drops*

at what point an increase in the cost of the pack is no longer offset by reduction in loss through breakages.

In choosing a suitable cushioning material several factors have to be taken into account. For example, the relative effectiveness of two types of cushioning material may be reversed for large and small drops. This is shown in Figure 8, which compares the relative behaviour of sponge rubber and resin-bonded fibre for different heights of drop. For low drops, the fibre is the more effective in reducing the peak acceleration; on the other hand, for large drops the fibre type fails altogether. This is because it acts as a sort of spring which is only effective when not fully closed; once all the fibres are closely rammed together its effectiveness as a cushioning material vanishes.

The effectiveness of various cushioning materials also depends upon the temperature, as at low temperatures the hardness of many of them increases. This does not necessarily mean that they fail in use, but it can mean that their effectiveness is impaired under extreme climatic conditions. This can become very important, for example, in goods intended to be carried by freight aircraft in unpressurized compartments at high altitudes, or for military goods intended for active service in Arctic regions. Moreover, many cushioning materials tend to age, particularly under the influence of light and air. Under prolonged compression they tend to acquire a permanent set and are no longer so resilient as they were when new.

CLIMATIC HAZARDS

No less important than the journey hazards are the climatic hazards which a package may have to undergo during its journey. Of these, the most important are exposure to high temperature and/or relative humidity, torrential rain, and cyclic changes of temperature producing condensation within the packaige Generally speaking, the most harmful effects of extreme climates occur at hgh. relative humidity. Rusting and corrosion of metal parts are greatly accelerated in relative humidities above 65 per cent, and the same applies to mould growth. In addition, the goods may also be attacked by corrosive gases such as sulphur dioxide.

There are several ways of dealing with this problem, the commonest being to enclose the goods in impermeable film which is either moulded round the article to be protected, or is in the form of a container which can be sealed afterwards by heat or by the use of a suitable adhesive. A desiccant may or may not be included. Recent years have seen the appearance of a bewildering number of films of various types and properties. Which of these is to be employed for any given purpose depends upon cost and the particular properties which are regarded as of greatest importance. Films in current use include: cellulose film, polyethylene, cellulose acetate, saran, various vinyl films, Pliofilm, polyester films, polyvinylidene chloride, polypropylene, polystyrene, nylon, polyisobutylene, polyvinyl chloride, benzyl cellulose, acrylics, terephthalate polyesters, polyamides and polycarbonates. A recent review of some of these has been made by Waeser;[1] they are being added to almost weekly. New polymers, of which much more may be heard in the future, are those containing fluorine. These have many remarkable properties including an exceptional resistance to chemical attack. For example, it is reported that vinylidene fluoride[2] containing over 59 per cent fluorine can be easily extruded, and the film can be formed by extrusion or from dispersions by spray coating or casting. Its remarkable properties include strength and toughness, chemical resistance, weatherability, thermal stability and low cold flow. One possibility for its use is as a coating over metal. It is reported that a piece of beef was wrapped in the film, heat sealed and then irradiated to sterilize it. The meat was still in edible condition after exposure to ordinary room temperature nine months later. Another fairly new film is polypropylene.[3] This has properties which should make it especially suitable for use for packaging in the food industry, particularly for bakery products, also in the tobacco industry and for the machine overwrapping of textiles and paper goods. Another new rubber-like film recently reported is derived from polyurethane plastic.[4] This is reported to be five times stronger than other films; it is unaffected by air, gases, petroleum and low temperatures, and is abrasion and tear resistant. It is said to be particularly suitable for packaging processed foods.

To give a detailed account of all these different materials and their uses would require a paper in itself, and a long one at that. It is seen, however, that we have a long series of materials ranging from the almost impermeable metal foil on the one hand to permeable untreated paper on the other, and a selection can usually be made to suit the particular requirements of the goods that are to be wrapped.

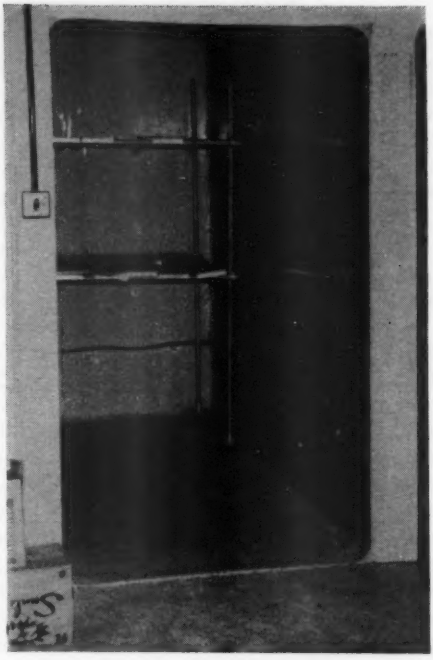

FIGURE 9. *Controlled climate room*

It should be noted, however, that tests on the material itself are not necessarily a guide to the properties of the finished package. Folding of some films impairs their usefulness considerably; probably the most notorious in this respect is waxed paper. Moreover, the seal is usually the weakest part and needs special attention if the efficiency of the package is to be maintained. At PATRA House, we have a variety of climate-controlled rooms for testing finished packages for their resistance to adverse climatic conditions. One of these is illustrated in Figure 9. These provide a variety of climatic conditions including hot/dry, hot/wet and cyclic conditions whereby the articles are subjected to progressive changes in temperature with condensation during the cooling cycle. Packages may also be subjected to low temperatures and any special conditions which may be required. They may also be sprayed with water to simulate monsoon conditions (Figure 10).

LIGHT AND RADIATION

An additional hazard which packaged goods may have to undergo is exposure to light or radiation of various wavelengths.[5] This problem has become more acute

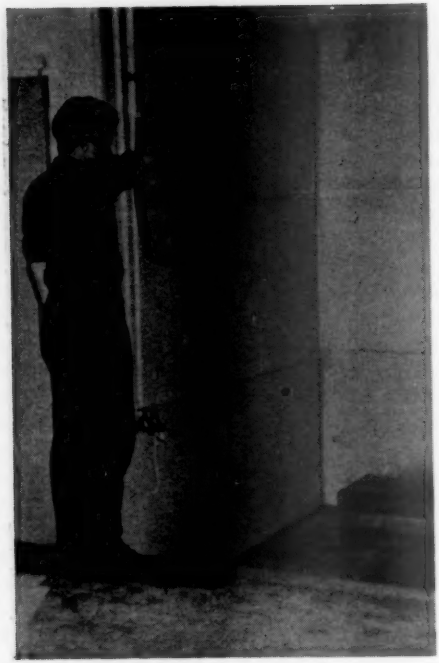

FIGURE 10. *Spray booth*

on account of the increasing tendency to package foodstuffs in containers containing a transparent window so that the quality may be seen by the purchaser. This is an important factor in the sales appeal of a package. Unfortunately, the breakdown by light in the vitamin content of a vegetable cannot readily be discerned. Some interesting experiments in the packaging of milk in brown bottles were reported recently in Sweden and Denmark.[6/7] From tests made on a number of consumers, it was found that the taste and also the vitamin content of milk was greatly improved by bottling the milk in dark brown bottles so that the ultra-violet content of daylight was excluded. Unfortunately, it was found in Holland that the gain from this cause was more than offset by the loss due to heat rise in summer.[8] The temperature of milk in brown bottles rose some 7 degrees higher than in the corresponding clear glass bottles, and the high temperatures caused rapid deterioration of the milk. For this reason, the experiments have now been abandoned. Most packaging films transmit the nearer ultra-violet quite freely. This might be excluded by the application of a varnish or the incorporation of a colourless dye, but, as the experiments on milk have shown, even the visible part of light can cause deleterious effects.

BIOLOGICAL HAZARDS

We have not yet come to the end of the list of hazards which the package may have to undergo on its way from manufacturer to consumer. The package may have to withstand attacks from bacteria, moulds or insects, and identification of these organisms becomes very important since the conditions required for them to flourish vary enormously. The commonest damage under this heading is done through mould. Broadly speaking, moulds do not grow rapidly at relative humidities under 65 per cent, but at 70 per cent and over the spores of some varieties germinate. At 90 per cent humidity, the spores of nearly all of them germinate rapidly. Apart from their unsightly appearance, these moulds cause extensive damage to the materials on which they feed. Thus, degeneration and final break-down of cellulose fibres can easily result. There is, therefore, a constant search for materials which can be incorporated into paper, board or other packaging materials in order to inhibit the growth of moulds and repel possible insect attacks. Thus Viado and Labadan[9] describe tests carried out in the Philippines from April, 1956, to November, 1957, to determine the effectiveness of impregnating sacks with D.D.T. to protect maize stored in them from insect attack. The treatment was found to cause a significant reduction in infestation. Burke has described recently some barrier materials claimed to be fungus proof.[10] Hentschel has given a brief description of the principal fungi, bacteria and insects which attack paper.[11] He discusses the choice of protective agents for paper and the use of such treated papers in packaging for tropical conditions and for certain other special applications, such as the covering of cables. Galloway[12] illustrates the fact that plastic films, such as polyethylene, that allow some oxygen transmission do not necessarily prevent mould growth at the surface where the food is in contact with the film. If such a film is laminated with cellulose film, then no growth occurs on the food in contact with the laminated film. Various types of plastic film differ widely in their transmission of moisture vapour and of gases, such as oxygen and carbon dioxide. A closely fitting moisture-proof wrapping should check both moisture loss and mould growth, but to ensure no mould growth it is necessary to use a film that is reasonably air-proof.

It is evident that here again is a large field open to the specialist, and the importance of preserving foodstuffs from biological attack can hardly be over-estimated.

MISCELLANEOUS

One or two miscellaneous developments need passing mention. There is, for example, the problem of corrosion produced by packaging materials. Dentists' or surgeons' instruments can be rendered completely useless by even slight rusting or corrosion. It is not only necessary in packing them to see that excess atmospheric moisture is excluded, it is also necessary to ensure that these packing materials, particularly paper, do not contain chemical residues which might cause corrosion. The commonest of these residues are chlorides, sulphates and acids. Thus, Takahashi[13] reports from tests made on mild steel pieces kept for two weeks at high humidity and temperature, that in order to avoid corrosion the chloride content of

the wrapping papers must be less than 0.5 milligrams per square centimetre as sodium chloride. The pH has little effect when it is higher, that is, less acid, than 5.0. Takahashi reports that the corrosiveness of the wrapping material cannot be established from the specific conductivity of an extract from the paper.

In addition to the choice of suitable wrapping materials, protection from corrosion can be increased by the incorporation of certain vapour phase corrosion inhibitors in the paper. Thus, Zawadzki[14] reports that steel wrapped in dicyclohexylamine nitrite paper shows no corrosion after six months in transit to the tropics, and the same inhibitor is effective in protecting phosphated steel under conditions of high humidity.

Another development about which we may well hear more in the future, is the preservation of foodstuffs by enclosing them in a sealed wrap and then sterilizing them by irradiation. The first large-scale plant for the irradiation of packaged goods has come into operation at the Wantage Radiation Laboratories of the Atomic Energy Research Establishment.[15] This method of sterilization is likely to be of particular value in the packaging of medical supplies. Irradiation is effective in sterilizing meat but it usually has an adverse effect on its flavour and odour, and although this taint may disappear on cooking, it is objectionable from the sales point of view. As an alternative to irradiation, antibiotics are now being tried.[16] Under suitable conditions these enable the shelf-life of packaged foodstuffs to be extended.

I conclude this review of technical advances in packaging with a feeling of great inadequacy. The field to be covered is vast and interesting, but only a series of lectures could do it justice. There is no doubt at all that packaging is now an integral part of modern life and is here to stay. Rapid development in all directions is to be expected. I hope, however, that I have been able to say enough to show that packaging is not just putting an article in a suitably shaped box. The reasons for packaging are complex and varied, and the ideal pack can only be achieved by careful work which demands the co-operation of engineer, chemist and designer.

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DISCUSSION

THE CHAIRMAN: We have enjoyed a most informed and instructive review of the techniques which are available for testing packages to ensure their suitability to withstand the hazards of transit, of climate, time, radiation and bacteria, and it may well be that before long Dr. Harrison will be testing packaged humans for their trips to the moon.

MR. H. E. COTTON (Vauxhall Motors Ltd.): About these cycles in the humidity chambers: may I ask Dr. Harrison if he measures the number of cycles in terms of shelf life? What relationship do these tests in terms of cycles mean in the shelf life of, say, a package?

THE LECTURER: The object of them is to imitate what happens in tropical countries, and for that matter in this country too, where in a certain season of the year one may get a quite high day temperature followed by a rapid fall at night with a corresponding rise in humidity above the dew point, when one gets condensation of liquid water over everything. That happens to my car. For instance, in the spring and the autumn I get condensation over the plug lead and then it is impossible to start the motor. These cyclic rooms are so set up that you can get a slow rise or fall of temperature of one cycle a day, or as you may wish to arrange, in order to simulate this particular effect of the condensation, particularly inside the packet itself. The length of time for which goods may be left in these depends of course on how long you want to test. It is not normally an accelerated test. If you want to know what is going to happen in this treatment you must give it adequate time. But we have found that mere exposure to constant high temperature, or high humidity, may not be enough. This effect of a hot day and a sharp fall of temperature at night with a heavy dew, then a rise in temperature again in the day, will give you better information on packaged goods. A case in point is certain sweetmeats which, with liquid water inside the packet, are soon congealed and become a solid unusable mass.

MR. W. R. A. BARNETT: Dr. Harrison did not mention spring systems in packaging; I should like to ask him if he has conducted any tests or investigations in that direction. I have seen quite a number of spring systems in use and they seem to have certain advantages.

THE LECTURER: In addition to the research which I described we run a package testing service and a packaging advisory service in which packaging problems are investigated and recommendations are made. The spring systems are particularly valuable in the carriage of delicate machinery where it is desirable not to have any contact with the box or cushioning, if it can be avoided.

In certain cases one may have the particular part more or less suspended in mid-air by a system of springs. It is rather an expensive method of packaging, but if it is for something particularly valuable which must reach its destination without damage, then it is a very useful form of protection.

MR. J. A. TOOMBS, F.B.D.S. (The Metal Box Co. Ltd.): Dr. Harrison has told us a little about sterilization by gamma rays and antibiotics. Could he tell us a little more about the dehydration of foodstuffs recently carried out at Aberdeen, and what material he foresees as being the protective material for those foodstuffs?

THE LECTURER: We have not done a lot of work on this particular subject, but during our investigations we have had to investigate dehydrated goods of various

types. The main problem is to keep the moisture down, because once the moisture content of the dehydrated goods rises above a certain amount then they become useless. The very critical cases we had to examine have usually had to be put into glass bottles or some container that is practically impervious, and very special attention has had to be given to the sealing, which is generally the weak point.

A lot will depend on the shelf life you wish these goods to have. If it is only a matter of a few days then some of the more impermeable films might be sufficient. If they are going to have a shelf life of weeks then I think you will probably have to get right down to the impermeable materials like metal foil and glass. The basic problem is to keep the moisture content as low as possible.

MR. STANLEY W. BOWLER, F.R.P.S.: I hope Dr. Harrison will not think me facetious when I say that in some instances we have found that the safest way of sending goods to the consumer is by not packing them at all, but simply by tying on a label.

On a more serious note, I should like to ask him to comment on the use of the modern moulded expanded plastic which almost hugs the product. This square pack of moulded material is slid into a sleeve or it may, in turn, have a moulded plastic cover formed around it, just sealed by an adhesive band.

THE LECTURER: There are certain goods which it may be better to transport without any sort of wrapping. Not very long ago at my home we had delivery of a new bath, and we were horrified to see that it was delivered in a lorry with nothing except a few bits of paper in the bottom and a label on it. On enquiring the reason, we were told that experience showed that baths were handled rather more carefully when they were sent out in that way than if they were covered with some wrapping material, because their very nakedness made the operators more careful. In other words, to give adequate protection in such a case would probably be very complicated, leading to expense which the purchaser probably would not care to have surcharged.

The moulded containers for goods, I think, are very good. I have seen quite a number of them. They have to be tailor-made to suit the particular article, of course, and are rather expensive.

MR. J. ANDERSON, M.P.S., D.B.A., M.INST.P.: Some use is being made these days of thermo-plastic closures for containers. I am wondering if Dr. Harrison has discovered in his tests—particularly in the chambers where he cycles the temperatures and humidities—that these thermo-plastic closures expand at a greater rate in high temperatures than the containers, and therefore that the seals might be suspect in tropical areas?

THE LECTURER: Well, that is one of the things that we are looking for, and one of the reasons why we put articles into these climatic rooms to try to detect these weaknesses. In addition to the big rooms which I showed you on the slide, we also have a number of smaller ovens which are temperature and humidity controlled and in which we are constantly doing tests on these types of seals.

Generally speaking the seal is the weak part of the package; it can under certain conditions, through differential expansion, break down. Our humidity rooms themselves were made out of one material for precisely that reason, because in the earlier ones, where we made them of three or four different materials, although they fitted beautifully when the things were new, by the time they had been in high humidity for some time differential expansion caused breakages in the seals and serious leakages.

MR. C. BRIDGE: Dr. Harrison referred to sterilizing by gamma rays. Where paper is the only wrapping material, would he care to state the qualification which is necessary for the paper?

THE LECTURER: I am not quite sure that I understand your question. If paper is the only wrapping material it would not provide very adequate protection even if the material inside were sterilized for the time being.

MR. BRIDGE: Bandages, for instance.

THE LECTURER: For the things which are to be sterilized you would want some much more impermeable outer wrapping film than just plain paper. You have your complete pack of bandages in an ordinary wrapping, but it will also be enclosed in an outer film which is heat-sealed, or sealed in some other way, and then the whole thing is irradiated to sterilize it inside. I do not think it would be effective just to sterilize the paper pack of bandages because of the porous nature of paper.

MR. ANDERSON: If you approach a laboratory about the testing of your package, is there not a tendency for the laboratory to overstate the cushioning properties? Do they not tend to err on the safe side and suggest the use of, say, a 90 board instead of a 60—whereas in actual practice you could get away with a 60 board, even for export purposes?

THE LECTURER: Yes, we have had just this sort of trouble. Laboratory scientists tend to be cautious and like to be quite certain of their findings. On the other hand, if we say you will get away with fifty per cent of the wrapping material and the article comes to grief, then we hear about it.

We and similar packaging stations do try to recommend the minimum that really will do the job, but it is sometimes a very difficult problem to decide what that minimum is, and what factor of safety you will employ. It may very well be that if you halve that factor of safety you will still get away with it, but it is hardly worth taking the risk. We do hear of people giving quite ludicrous amounts of packaging, but I think experience over many years is really the only guide, and it is very helpful if the people at the consumer end, and the manufacturers, will report to the testing stations what actually happens to the packs.

MR. BOWLER: I think the *minimum* criteria for many is Railway Certification. This does not necessarily mean that the package is going to arrive intact, but it does mean that you can claim the insurance if it does not! [*Laughter.*]

MR. P. E. CANETTY: I was rather alarmed by those oscilloscope curves comparing various forms of cushioning. I should like to ask Dr. Harrison how conclusive is the evidence that he has produced? Can one place a very great reliance on this or should we take it with a certain amount of discretion?

THE LECTURER: The experiments on these particular materials have been carried out very carefully and I think the results are reliable. But in choosing your cushioning material you have to consider the sort of shocks and stresses you are trying to insulate against. I showed on a slide, for example, that one material which was perfectly good for twelve-inch drops was not good for thirty-six-inch drops; it may very well be that you decide to have your pack made to stand up to only twelve- or eighteen-inch drops.

Again, there is the question of cost. Some of the materials which we have examined are comparatively expensive and could not be used for quite a lot of freight. Full reports will be published on all these aspects, but I think they will not point to any sort of royal road to cushioning. Packaging unfortunately has often to be tailor-made to suit a particular job. We have, for example, very little information on what happens to packages rolling about in ships' holds in a stormy sea, or on aircraft, but we are slowly forging ahead with tests both here and on the Continent.

THE CHAIRMAN: The time has come to thank Dr. Harrison formally for his admirable paper, which I for one shall look forward to reading, together with this discussion, in the *Journal*. We all now know where to go when we have packaging problems on our hands. We thank him very cordially for his most interesting and instructive address.

The vote of thanks to the Lecturer was carried with acclamation, and the meeting then ended.

THE FUTURE PATTERN OF UNIVERSITY EDUCATION IN THE UNITED KINGDOM

A paper by

J. S. FULTON, M.A.,

Vice-Chancellor, University of Sussex, read to the Society on Wednesday, 10th May, 1961, with R. O. Buchanan, M.A., B.Sc., Ph.D., Professor of Geography, London School of Economics and Political Science, in the Chair

THE CHAIRMAN: Mr. Fulton is going to speak on the topic very dear to his heart, and one on which he has himself done more work than almost any other academic man in this country. It is a topic of vital interest and importance to our country at large, and more particularly to those generations of students who have not yet come along, and through them to their parents. Mr. Fulton's own experience is wide and varied. He has been the Principal of the University College at Swansea and is now Principal of the new University in Sussex. He has visited and advised universities in various parts of the world. He is a man who thinks clearly and speaks pertinently. I can assure you you will be left in no doubt whatever as to his views on the matter.

The topic is one that could be treated in all sorts of ways: the mere numerical aspect, for instance—the number of new universities required; the amount of expansion in existing universities; the number of places to be provided; the amount of money requisite for the buildings and staffing and so forth—all of those are problems that could be discussed and indeed have to be discussed. But I think you will find that Mr. Fulton chooses a different aspect, a more fundamental one, the nature of the job that universities have to do and the way in which they do it.

The following paper was then read.

THE PAPER

My title calls for a word of explanation and, I fear, of apology. When the Royal Society of Arts did me the honour of inviting me to give this talk it was before the appointment of Lord Robbins's Committee. As we now know, he and his colleagues are to examine the pattern of higher education in this country, to make recommendations about any changes required in the pattern; and the possible need for bringing new types of institutions into existence is included in their terms of reference. My subject 'The Future Pattern of University Education' would, at any time, have been an ambitious one. In the context of Lord Robbins's Committee, I am afraid it must seem to have tumbled over the edge of the abyss into presumption. So I need to reassure myself, even more than you, that the ground that I shall cover will be modest and circumscribed.

The issues upon which Lord Robbins and his colleagues will engage themselves cover the whole range of higher education, i.e., the full-time education of those over 18. The pattern of university education is a major part of these issues. It is

not easy, even for those who have spent their lives in the universities, to be precise in defining the pattern. We have Oxbridge, with traditions shared in common with Paris and Bologna; we have the Scottish universities inspired by the example of the medieval German universities; we have London containing over one-fifth of the students in the country; federal in constitution; with grown-up offspring in many of our modern civic universities as well as throughout the Commonwealth and colonial dependencies; and owing much of its special character to its metropolitan environment; we have Redbrick, the civic universities of the nineteenth and twentieth centuries, largely local and regional in their origin, now changing—if they have not already quite changed—to a national model in both teaching and research; we have Wales, a national university, collegiate and federal; lastly, we have the new universities beginning with North Staffordshire, now joined by Sussex, York and East Anglia, and soon, one must expect, to be further reinforced by other new arrivals into the university family.

If it is difficult to distinguish within this diversity a common pattern, it is perhaps possible to discern a common element which all the universities in this country share and which distinguishes them from the other institutions of higher education. We have expected our universities to provide for only a comparatively small proportion of each age group; moreover, they have given an education leading to a first degree of a very high standard. Although from the very beginning of their history our universities have included within themselves professional schools such as Medicine, Law and Theology, their Faculties of Arts and Science have offered an education essentially non-vocational in its character. That is to say, it has been part and parcel of the arrangement of university affairs that in the Faculties of Arts and Science the student was not being specifically prepared for a professional career directly related to the field in which he was studying at the university. Many scientists, of course, study science in order to become scientists or teachers of science; many arts students study arts subjects with a view to teaching them at universities or in schools; but it has been an essential part of undergraduate education that the career or vocation to be followed thereafter by the graduate did not cast its shadow backwards over the teaching of the subject at the university.

Alongside the universities, we have provided a number of specialist institutions in which precisely the reverse is true. We have colleges of advanced technology, technical colleges, veterinary colleges, agricultural colleges, teacher training colleges, schools of drama and art, colleges of the military science appropriate to the Army, the Navy and the Air Force. For entry to all of these it is necessary for the student to commit himself at 18 or so in a more or less final way to the career that he is going to follow. These institutions have, of course, done as much as lay in their power to provide a general education for the personal development of the student. But their primary purpose and what gives them their character is that they are required to turn out specialists in a particular field in which the young person has already determined to seek his career.

Apart from their own professional Schools of Medicine, Law and Divinity, the universities have been by tradition general in their approach to teaching. Their

object has been to bring the undergraduate's mind to the height of its intellectual power through study in a field chosen by him and in which the goal set is a very high level of academic attainment. Further, he has been given a spacious environment in which to develop these intellectual powers, and the atmosphere of discovery and inquiry with which he has been surrounded has been intended to stimulate his curiosity and capacity for independent judgement.

Given then, these two types of institution—the broadly general non-vocational university and the specialist vocational college—as the existing pattern of higher education, how do we see it in the future? If the experience of the Robbins Committee resembles that of the Crowther Committee, it is pretty certain to find—at least, I shall be surprised if it does not find—that there is far greater scope and far greater need for higher education than we are at present providing in this country. If, as I suspect, there are many missing it for one reason or another who ought in their own, and in the public interest, to be having full-time education after the age of 18; and if we are determined, as we ought to be, that they shall have a more adequate opportunity, we *could* add the extra numbers to the universities and to the specialist colleges in a proportion similar to that already existing between them. By another choice, we could alter the existing balance and send a disproportionate number of the increase into either the universities or into the specialist colleges. Thirdly, we could invent new types of institution and find a suitable method of determining how the total of young people qualified for higher education should distribute themselves in the most appropriate way between the different types of institution.

I am inclined to suspect that any attempt to determine *a priori* the proper proportions of young people who should go to different types of institution would be of very doubtful value. It is, of course, true that the number of places—especially science places—in a university or a college is, in the short run, fixed by physical conditions. But it is also true that, in the long run, the numerical relationship between the young people in different kinds of institution will be determined by the choices of the young people themselves and by what their parents and their schoolmasters think they will get out of one kind of place rather than another. Prediction about how these choices will be made is, at best, a mere guess. We do not know how much the attraction of students towards universities is the result of their monopoly of the degree-giving power. Suppose, for example, that other types of institution than universities were given permission to award degrees, how would this affect the candidates' choices? It is impossible to say and only experience could decide.

The moral, which it seems to me we ought to draw from these considerations, is that we should make as clear to ourselves as possible what the rôle of the different types of institution is: what each offers: what does each conceive its task to be; if we do this, then the choice of the young and the advice of their parents and their schools, will be as well-informed as it can be, and those who seek to take the university road, or the other possible roads, will be self-chosen on the best information that is open to them.

My subject is the universities; and so I come to the question of what the

university does or should do for the young. I want to spend a little time in seeking some answers to this question.

Of course, first of all, the university prepares them for their job in life—but not, as I have already said, by giving them a know-how which is restricted to any particular type of occupation. It does not nowadays prepare them only for the learned professions as it tended to do as recently as even fifty years ago. The function of the university is to bring the young people entrusted to it to the height of their intellectual powers by setting them to do a very exacting academic task. I emphasize the word 'academic' because the practice of our universities has been based upon the assumption that young men destined for one of a great variety of tasks in life—in public life, in the schools, in law or in the Church, in the public services, in industry and commerce—will be better prepared if for three or four formative and very important years of their lives they undertake at the university courses of study in common with those who are going to be scholars. There can be no doubt that this tradition has left its mark indelibly upon the social, political, educational and industrial fabric of this country. It has given the universities public responsibility and prevented them from being what are called 'ivory towers'. Thus, the effect upon them has been profound; they, in their turn, have deeply affected, through those whom they have taught, the course of public life and of our affairs in general. The Member of Parliament who has read his history at the university in friendly rivalry with the future historian, inevitably reflects in his parliamentary behaviour the academic experience through which he has passed. The fact that Mr. Gladstone could have been a professor was profoundly important both for the university which missed his services and for the party and public life which gained them.

The second thing which the university does is to give to its students a special experience in which they gain an abiding insight into a university's perspective. Judged by the standards of ordinary daily life, university life is, in some senses, an odd one and university people seem, perhaps, to the layman outside, rather odd people. I need not try to explain at length why this should be so; I will just say this: on the one hand, normal daily life is largely concerned with the problems of the present or those of the quite near future, with the hopes and anxieties of day-to-day existence; on the other hand, the universities live in a world with a quite different time-scale, and the problems which exercise the academic mind belong to that world. For instance, they are interested in the past—not only of yesterday but of fifty, a hundred, even millions of years ago. They are interested, too, in the future, but they are as likely to be interested in the problems of many centuries ahead as in those of only fifty years from now. They are interested less in the day-to-day behaviour of men or things than in the laws that govern that behaviour or explain it. They are concerned less with the appearance of things than with the underlying nature of which that appearance is a reflection. I have perhaps said enough to indicate why the practical workaday man thinks that university people, are, as he would put it, 'out of this world'. Of course, they are. Rightly regarded, the academic is indispensable to civilization only so long as he remains academic in the sense I have described. For his part, he is entirely right to be indifferent

to the charge of belonging to a world of his own, in which the practical man of affairs would be ill-at-ease.

One hopes, therefore, for the young man or woman who is to spend three or four years at the university that they will take something of this spirit out into the world with them. Some, indeed, will be captured by the spirit of the place and will be at home with academic values and wish to spend their lives cultivating them. Among these will be found the professors and university teachers of the next generation. Others will fall under its influence only for a time and will then return to the world outside; but not, one hopes, to be ever quite the same again. For we, in the universities, hope that they will see the problems of here-and-now—whether they are the problems of personal conduct, of public affairs, of art and literature, of science and its applications—illuminated by the studies of their university years. In other words, what the student needs from the university is not just a little (or even just a great deal) more competence in the subjects he has studied at school; not just to have a few rough edges knocked off his mind; not just to learn more elaborate intellectual skills; not what, in the modern idiom, is called 'know-how'. He is going to be a member for three or four years of a society which has its own characteristic way of life. From it, he can learn much that will enrich both his personal life and the service which he can give to his own day and generation. Of course, the student must leave the university a master of the field he has chosen for his own, whether it be chemistry or history, Oriental languages, or engineering science; but in helping him to find that mastery the university must also help him to catch a glimpse and to acquire a taste for the 'other worldliness' of which I have spoken.

The third thing the university does for its young people is to give them their education and the experience of which I have talked, in a special kind of environment. It is, of course, a protected and, in some ways, an artificial kind of environment. But it is not, for that reason, without great power to impress itself upon their minds and to retain its impression upon them for the rest of their lives. The society to which I myself belonged in my own College at Oxford was, as I well recall, of this latter sort. From the day of our entry we were taught by the ethos of the place, rather than by any formal instruction, to feel that its strength lay in the diversity of experience which its members brought to the common stock. When we were joined by a new kind of undergraduate of a different nationality, race or colour from a part of the world which had never supplied a member before we felt that it was a stronger and better place. The first time that an extra-mural scholar arrived, fresh from his job as a 'bus driver in Bristol, we were prone to believe that the College had, in some way, been strengthened. When a German Rhodes scholar first returned to the College after the First World War we felt that it was a better place. We were taught, in other words, that the ideal society was one in which every single member made his own unique contribution to the diversity of gifts which we disposed of in common. And, by implication, we learnt that uniformity and the repetition of identical experiences were a weakness and something to be avoided. We were, of course, free to accept or reject this philosophy which underlay our common life; but looking back on it I feel that the young men of the '30s,

the successors of my own generation, were, in fact, prepared in the most positive possible way to know their mind when the challenge of the dictatorships fell across Europe. For this part of our education there was no formal, overt teaching. What we learned cut across the boundaries of social groups, of religions, of nationality and of race; it was a lesson equally on offer to arts men and scientists; it was among the most effective teaching that I have ever known.

Another thing that a university should try to do for its undergraduates is to help them to become their own masters. As my experience of universities has widened, I have become more than ever convinced of the importance of this function.

The university years, though primarily for the training of the intellect, have never been thought to be without their importance in the training of character. Indeed, in some quarters it has been made a subject of reproach that our universities have laid too great an emphasis on the training of character. It is a charge to which I hope they will continue gladly to submit. The undergraduate years are the period between a regulated school life (reaching out to emancipation in the sixth form) and the compulsions of earning a living in the workaday world. These years, if they are used to the best advantage, offer an opportunity to grow successfully out of adolescence into manhood and autonomy of will; it is of the utmost importance to the individual that he should seize it. The right incentive for the average student to do a good day's, a good term's, a good year's work is neither a carrot nor a whip. The born scholar is not a problem to himself or to his teacher. He is carried along by his devotion to this subject. But the number of natural scholars was never large in our universities; for the remainder, motives are bound to be very complex. Where the course is on vocational lines, that is to say, apparently leading directly, as in medicine, to a profession or vocation chosen by the student in advance, there is usually no serious difficulty; whatever day-to-day difficulties he may have, in the long run his impulse is derived from the professional goal. Among a large number of science students there is a similar kind of drive; for the general acceptance of the importance to our society of scientists, and of the scientific activity, helps to produce an answer to the question 'why should I be doing this', and even to the question 'why should I be doing it *now*' (that is, not postponing until to-morrow the drudgery that seems distasteful to-day)—questions which might otherwise fail to find an answer. My experience suggests that the difficulties are greater in the Arts Faculties than elsewhere. Apart from those who are natural scholars and those who are proposing to teach the subject in which they are studying for a degree, the drive to work must come from a complexity of sources —ambition, habit, a sense of responsibility to parents or to the society which finds the means to provide the student with his education. But it has to be admitted that, in many cases, the relevance of his study to what he is to do when his undergraduate days are over is, for obvious reasons, harder for the arts undergraduate to see than it is for his fellows in science, medicine, law or engineering. It is, perhaps, a sign of grace on his part to ask to be shown the relevance of his studies to the contribution he may make to society afterwards. There are real difficulties here; they can be solved only by the undergraduate coming to terms with himself. Perhaps we ought to admit that the universities' methods of dealing with this

problem are sometimes rather crude. The requirement that one should attend a certain proportion of lectures to qualify for entry to a degree examination is an external sanction with little obvious relation to the internal problems of the undergraduate's life. In the long run, he has to settle the matter *in foro interno* for himself; yet in coming to terms with his work he can be greatly helped by his relationship with his teachers. It has been one of the great merits of the tutorial system that it combines a framework of discipline (the requirement that essays shall be prepared, produced and discussed with a tutor at regular intervals) with a wide range of freedom for the student himself to choose the way in which to set about the task and to carry it through. In other words, it requires him to do the job for himself; but it does not leave him without encouragement and support at the right times; moreover, it fosters a relationship between the more experienced teacher and the younger undergraduate in which the attitude to work, as well as the content and the quality of the work itself, becomes a matter for their common concern.

The last general responsibility of the university towards the young, of which I want to speak, is to give them the opportunity of determining the values by which their lives are to be guided. I do not mean to suggest that the choice of values of any generation is entirely in the hands of those with the greatest academic ability who come from what we may call the 'university stream'. But it is certain that those with the highest endowments will bear a great deal of responsibility for the way in which their generation sums up the values it has inherited from the past; and for helping to modify them to suit their own times and their own moral priorities and their own sense of fitness. The university—if it is to do this adequately—must be a many-sided multi-faculty society and must offer opportunities for a common life in which there will be an exchange of ideas between students following different courses. The so-called 'nine to five' university (does it anywhere really exist?) which is deserted after 5 p.m. and where the working day is totally absorbed in the prosecution of the formal curriculum, is objectionable on this ground. The case for students' residence, which can be supported for other reasons as well, is most strongly grounded in this line of argument.

These, then, are some of the things which the university has to do for its undergraduates. It will not have escaped your notice that I have said very little about the university's function of original inquiry, of research. This is not because I underestimate its value nor the strength of the hold which it rightly retains on the academic mind. On the contrary, none of the gifts which the universities ought to give the young would be in their power to confer unless they were creative societies —creative in the sense of finding out what is new, or rediscovering and reinterpreting for contemporary society what has abiding value from the past.

Let me turn for a moment to one of the most recurrent criticisms of the universities to-day. It is often said that the education of the young is too specialized and that their outlook is accordingly fragmentary and blinkered. I do not think that it is intended to suggest—or if it is, that the charge could be supported—that all work in depth is harmful for undergraduates. The natural gifts of many of them —many of the best of them—will be developed only by determined and often lonely

and unaccompanied tunnelling into an unknown landscape in pursuit of the light that may be found at the far end of the tunnel. What is being questioned, and I feel with justice, is whether this is the method that all—even all of the able ones—should follow. For my part, I am convinced that the idea of the single-subject Honours course as the sole, or at any rate the best, means of educating our ablest young men and women, has been pushed too far. It has, of course, met with notable and successful resistance in the continuing prestige of the Oxford School of Greats (and, since the end of the First War, the School of Modern Greats).

The essence of Greats is that it requires the undergraduate to study a civilization as a whole—its literature, its history and its thought (about the natural as well as the moral order). Greats was never intended to be, and has never been, a refuge for those thought to be unable to profit from concentration on a much narrower field. For the most able, as well as for the less able, Greats satisfied (and I have no doubt still does) the most exacting tests of what constitutes a good undergraduate education. It has depth to give discipline; each branch of the School illuminates and gives an insight into the others; and it is a study of a whole and not merely of one of its aspects or parts. Clearly, there is little or no relation between this type of course and one in which several distinct parts, unrelated to one another, each occupies only a fraction of the student's time. Given the choice, on the one hand, between a study of one single subject in depth and, on the other, a number of unrelated subjects at a fairly superficial level, an able student should choose the former and reject the latter. But this is not the only choice.

At this point, I think it would, perhaps, be pardonable if I said a word or two about the shape of the courses being planned in the new University for which I am, in part, responsible. I ought to say that the first students are being admitted in October of this year. They are a small number confined to the Arts Faculty. In the following year they will be joined by a much larger company divided equally between the Faculties of Arts and Science. As a consequence of these arrangements, the planning of the arts courses is a good deal further forward than that for science. But the courses in both are being planned in the light of the considerations to which I have just referred. Two principles seem to us of primary importance. First, that there should be a core of specialized study (in literature, history, social studies, philosophy); this will be his study in depth through which the student will acquire his intellectual discipline. Second, together with intensive work on this 'core', he will be required to study the approaches involved in other disciplines. These will be the subjects which give a 'context' to his specialized work—its historical perspective and its relation to contemporary problems and issues.

To make sure that these principles are adhered to and that the standing temptation to fragmentation of studies is successfully resisted, an important break has been made with current university practice. There are to be no Departments in the Arts Faculty (nor, so far as concerns the control of the curriculum, in Science either); instead, there will be Schools. In the Arts Faculty there will be, at first, Schools of European Studies; English Studies; Social Studies; and, later on, Afro-Asian Studies. Each of these Schools will require, in proportions varying at the choice of the undergraduate, study in the three great divisions of the arts—

literary, historical and philosophical—brought together in the unity of a single civilization. The whole academic staff of the university will be engaged in a single enterprise, reflecting the unity rather than the discreteness of knowledge. Teachers will be free to belong to the Board of Studies of any School to which their subject contributes. We hope, too, that there will be a free trade in subjects between Schools: to take one simple example—although literature will not be a subject formally listed in the curriculum of social studies, a student of, let us say, social and economic history will be encouraged by joint seminars to throw light on his study of 'the Condition of England question' through the Victorian novel and the writings of such authors as Carlyle, Ruskin, Arnold and Morris. Thus every attempt will be made to keep the boundaries between Schools and, for that matter, between Faculties, flexible; and to prevent the academic rigidity of the Department from reasserting itself on the larger scale of the School.

If your patience will hold out, I should like to say one further word about courses and examinations. It is difficult to steer a safe course between overmuch detail, on the one hand, and too wide generalization on the other. Perhaps I can illustrate the shape of some of these courses by a brief account of what is proposed for the Final examination in the School of European Studies. Whether the undergraduate chooses this School with a bias towards history or towards literature, he will be required to take three papers common to all. The first of these will be European Foundations. It will be designed to provide some appreciation of the unity of European culture through the study of the European tradition before the Renaissance. The 'European tradition' is understood primarily as a tradition of moral philosophy and is exemplified especially by Plato, Aristotle, the Stoics, Cicero, Virgil, Augustine, Aquinas and Dante. The examination will be set on prescribed books. The second of the three common papers will be in philosophy: either

(*a*) contemporary philosophy and political doctrines; or
(*b*) political theories; or
(*c*) the history of scientific thought; or
(*d*) the history of art (including the principles of aesthetics).

The third common paper will be one on the contemporary world: either

(*a*) the political and economic structure of Europe since 1945; or
(*b*) international politics; or
(*c*) the modern European mind.

As European Foundations was intended to be a study of the European tradition before the Renaissance, so the Modern European Mind would be intended to provide an appreciation of the unity of contemporary European culture. These then would be the three common papers. Candidates specializing in history would have five papers in history covering what I have called the 'core'. They would also have two papers in literature relevant to their historical studies. Conversely, the candidate whose main interest was literature, would have five papers in literature to constitute his 'core' and two papers in a historical general subject, such as the History of Nationalism, the History of the Diplomatic System, the Development of Modern Science and Technology, the Relations of Church and

State, Transformations of the European Economy, European Colonization, the History of Democratic Practice, the History of War, the Development of Modern Government.

So much for curriculum.

Two other general comments remain. As I have indicated, the system of public examinations will be in two parts; the first public examination, at the end of two terms, will provide, as nearly as may be, a common preliminary for all the students in the Faculty of Arts. The course leading to the first public examination will provide the undergraduate with a general knowledge of the historical framework within which his later studies will be set and a working knowledge of the chief tools and concepts which he will have to employ later on. The common preliminary course will also ensure—what can be very valuable—that the undergraduate has an opportunity to discover, in greater leisure than is often now possible, the lines on which his interest is likely to grow—and that may well be on lines different from those which seemed most probable in the final stages of his career at school.

There is, finally, the question of teaching methods. In view of what I have said earlier, you will not be surprised to learn that we have committed ourselves to a tutorial system, based upon essay writing, as the main instrument of teaching. The task of integrating the various elements in the Schools, which I have described, is an exacting intellectual exercise; and for the student to make a success of it he will need all the help which individual attention can give. I do not think we are committed to an exact replica of the tutorial systems in operation at the ancient universities. It may well be that the critical period for the undergraduate (in which he most needs tutorial assistance) can be restricted to the first two years of his course; thereafter, with growing maturity, he may receive his help most effectively through a system of seminars. The lecturing system will be, in general, a voluntary one; a stimulant to the undergraduate's study rather than the main ingredient of his diet.

Mr. Chairman, you kindly asked me to speak to you about the future of the universities. I fear that I must have disappointed your reasonable expectations. I have said next to nothing about them as centres of fundamental research, a function in which they are, by common consent, pre-eminent; I have, on the other hand, spoken at length—you may think undue length—about their responsibility for educating the gifted youth of the nation.

This emphasis on educating the young is, however, perhaps more closely connected with the future shape of the universities than might at first sight seem likely. It may be that the frequent contacts that I have recently enjoyed with new universities overseas in the countries emerging from colonial to independent status have unduly influenced my judgement. There, what the universities make of the young is manifestly and beyond dispute of paramount importance to the future of the nation; the universities cannot escape, even if they wished, having responsibility laid at their doors; and they will inevitably be judged by the whole people as well as by the government. In these countries, of course, burning faith in education as a nation-builder and a passionate individual desire for it have spread with an explosive force unequalled since the foundation of Europe's universities in the

middle ages. Of course, the part played by these new universities overseas in finding through successful research solutions for the social, economic, scientific and technological problems of their countries will be of the utmost importance. But equally important will be the qualities, moral as well as intellectual, of their graduates; and the public's estimate of the latter will be both first-hand and immediate.

With us the explosion is less violent but it is evident to even the least observant eye. With every year that passes there is a spectacular rise in the number of applications for places at the universities. Moreover, the schools testify that a massive change is taking place in the attitude of whole groups of parents to the higher education of their sons—and still more of their daughters; where formerly there were indifference and even hostility these are giving way to interest and positive encouragement.

In these circumstances our universities cannot escape—even if they wished—concentrated attention upon how they serve the young—already the young themselves are showing signals (hoisted sometimes perhaps without overmuch discrimination or tact) of a critical interest in what they are taught, in how they are taught, and in the conditions under which they are expected to live and learn at the university.

When we take into consideration, as we are told we must, the trend towards earlier maturity and all that it implies, we cannot expect the undergraduates' interest in these matters to lessen. We can hope that criticism will be constructive and tempered with responsibility.

On the three main issues—what is to be studied, the method of teaching, and the nature of the university society—the undergraduate's responsible co-operation must be won. If it is not, most of the functions of the university, as I have described them, will be frustrated or ineffectively performed. We need more experiment, new types of curriculum, a wider variety of choice; on the new universities lies a special obligation to ensure that each new foundation brings something new and worthwhile into the general stock. But, of course, it remains true that curricula, devised with whatever care by an older generation, depend for success (Modern Greats at once springs to mind) upon their power to capture the enthusiasm and imagination of those for whom they are intended. About methods of teaching, all I can add is my belief that the nearer these come to a personal exchange of ideas between teacher and individual pupil the more likely will be the latter's growth into intellectual maturity and the autonomous management of his own life. Thirdly, the nature of the university society: as I have tried to show, it is from tension and conflict that new ideas are born. We should, therefore, welcome—what is often mistakenly deplored—the consequences in the universities of the social revolution of our time: not long ago student bodies were, by comparison with to-day, homogeneous in social and geographical origin. The new conditions, if we study and understand them aright, can be turned to inestimable advantage. A mixture of social groups: a mixture of geographical origins: a mixture of nationalities: all tend to enlarge the mind and to make fruitful the intercourse of ideas. If the young are to come to grips with the problems of their generation through a battle of ideas

with their contemporaries, let the ideas rest upon the widest possible basis of experience.

In conclusion, I make no apology for treating the university as a place for the young; not, I need hardly add, a place for the young to govern and administer—but a place in which, while the mind is reaching its full stretch, to grow into intellectual excellence and full responsibility as man and citizen. This will be possible only if they are given their place at the very centre of the university's life and thought; and if they are confirmed in the enjoyment of the great heritage handed down by the universities of the West—that the mind of the young should not be warped or twisted within the framework of a doctrine imposed by any authority but be set free to find conviction solely from the argument itself. These are the conditions necessary for the human spirit to lead in freedom the progress of our society.

DISCUSSION

THE CHAIRMAN: I promised you that your speaker would have firm ideas and that you would be left in no doubt about them. Like a good speaker, too, he has not stuck to facts, he has interpreted facts. His interpretation is of course very personal, and personal interpretations may well leave room for honest difference of opinion.

MR. P. K. SHAHANI: As we all know that society only progresses to the extent that it encourages the common man to do uncommon things, it has been very heartening to hear Mr. Fulton speaking about the education of the whole man. I should like to ask him how far he is in favour of elevating the public schools to the status of something like the liberal arts colleges, like those in America?

THE LECTURER: This is really two questions. One is a question whether it is desirable to have liberal arts colleges, and the second question is how they could be created. We are all having to think very hard about the first question (the second one I do not think I want to deal with to-night), but it is really on the plate of Lord Robbins. Many of us will have to try and think what we have to say to his Committee in helping it to reach a conclusion that will, I think, very largely determine the shape of higher education in this country for many generations. The figures give some kind of clue. I find it very difficult to believe that we shall ever get by without giving, as Sir Charles Morris has recently estimated, full-time higher education to at least about half-a-million young people at a time. The biggest number that has been suggested in recent discussions for the universities is 175,000 by 1970. Some people aspire to 200,000. The figure for training colleges is about 53,000. The figures for Colleges of Advanced Technology is quite small; if my memory serves it is of the order of 15,000 or 16,000.

Whatever figure one gives for the other institutions—and, of course, technical colleges are difficult to give a figure to because they are so much bound up with part-time as well as with full-time education—it is quite obvious that we are a very long way short of what we ought to be doing. I think there may be a great deal to be said for the proposal in part to fill the gap by inviting a new type of institution; but, in the long run, it will depend upon the judgement people form in answer to the question from which I started—Do we want a good proportion of our young people to be given a highly specialized education after they leave school, intended to prepare them for a job to which they are already committed; or do we think, as the Americans do, that a broad general education for three years from the age of 18 is a very good introduction to any kind of specialized activity they may prepare for later? These are the further questions which answering your question really entails.

MR. E. T. S. HOFFMAN (Principal, Tottenham Technical College): May I ask Mr. Fulton if he is satisfied that our universities are working in such a way that they are turning out graduates who are educated men and women? I rather doubt it myself. I feel that more attention must be given in all university courses to the elements of a good general education. I should like to feel that every university course included English right up to the final examination, and also gave students a working knowledge of at least one foreign language and the ability to appreciate music, art and certain other humanities. Until we can feel that 'educated man' is synonymous with 'graduate', or rather the other way round, until every graduate is an educated man or woman, we are falling short of what our universities ought to be doing.

THE LECTURER: This is again a very large question. In my previous institution we experimented with general education; in particular, we tried to do two things. We required all freshers to go to a course of lectures on the great figures of the nineteenth and twentieth centuries—the people who made us think differently from the way in which our grandfathers thought—in science, in psychology, literature, and so on. They did not particularly like it. We persuaded lecturers to come from all over the country and although, as one would expect, individual lectures were very successful, the undergraduates did not take to the idea.

The other thing which we tried to do was to make them write essays on general topics. There I think we had more success. We got one woman and three men (that was the ratio of the sexes in that institution), two scientists, two arts people, to write an essay on some topic of the day, and discuss it in the company of a senior person. That is to say, they could discuss some such subject as capital punishment as it appeared to them as scientists, or statisticians, or in whatever way they liked. When cross-examined, they defended the system of essay writing strongly though they had to take more trouble over them than in attending lectures. I do not know what the moral is, but I think a great deal could be done in ways like this in making people put ideas together from various points of view.

The problem of getting the young to understand that writing is a very difficult art is a very great one. They somehow think that the Professor is gifted by nature with the ability to write and that it is something for which he has not had to struggle. This is partly because universities have not been as insistent as they ought to have been about the need to make people put their thoughts down on paper as a way of clearing the mind. General education must largely be self-education; it cannot be handed out. This was the moral of the experiment we carried out.

MR. W. F. GUNN (King's College Hospital Medical School): What does Mr. Fulton think are the obligations of the British universities towards foreign, Colonial and Commonwealth students?

THE LECTURER: I have spent a great deal of time recently dealing with the problems of new universities in what used to be the Colonial dependencies. They have grown up very fast. There were three rather small, rather battered, colleges at the end of the War; to-day from the Far East to Africa there are fifteen or so institutions ready to become universities. These have been, for the most part, staffed from within the British universities. If they are to progress to the goals they have set themselves, I think it is very important that they should get the cream of their own students; no doubt, it is also important that we should help by taking students into our universities in the United Kingdom; this is obviously the best thing to do for the time being. I think we could help a very great deal by taking students from the overseas universities for post-graduate work here in the United Kingdom; but I should not want to close the doors to the undergraduate, and I think that for a long time ahead the figure of about 10 per cent of our students coming from overseas (which is the present ratio) is going to be necessary and right. I am sure it is healthy for us. The mixture of the students from overseas has a very important educational influence on

our young people. But as I have said, I do not want the flow to be so large as to impair their chances of building up first-class universities in their own countries.

MR. M. J. LIGHTHILL, M.SC., F.R.S. (Director, Royal Aircraft Establishment, Farnborough, formerly Professor of Applied Mathematics, Manchester University): Could I ask Mr. Fulton about the immediate past background of the students from this country? I should like to hear his views on how entrance requirements are affecting this intellectual cream who are going on to the universities. Would he agree that entrance requirements and scholarship requirements—and especially Oxbridge College scholarship requirements—are putting a very great strain on young people during those last two years at school, forcing them to a degree of specialization which I think he would not even wish to see in the university itself? I wonder whether he feels that a relaxation of the more intense scholarship requirements would allow the more gifted pupils at any rate in their last years of school to begin the process of general education?

THE LECTURER: I hope nothing I have said will be interpreted as meaning that I want to make less demand on the young. I believe that, on the whole, in educating our young people between the ages of thirteen to twenty-one, we are working on the right lines. No doubt, if we relaxed our standards, we could take in more and have bigger numbers. I don't want to suggest that we should make smaller demands on them. I think for quite a large number of them the present arrangement is, no doubt, very suitable. Whatever they are going to do at the university I do want them to come in with a good intellectual discipline behind them. Until there is a substantial number of universities who are going to offer the type of course that I have been talking about, as foreshadowed for Sussex, I don't believe that it will make all that difference to what goes on in the sixth forms. If our example were followed by another three or four universities the problem that you raised would be much eased.

DR. O. G. PICKARD, B.SC.(ECON.), M.COM. (Ealing Technical College): Will Mr. Fulton give us his views on the length of the university course? Is he satisfied with a three-year degree course?

THE LECTURER: I should very much like to have a four-year degree course; but if we think about the difficulty of getting 175,000 students into the universities by 1970 (and I am one of those who wants this to happen), that is crying for the moon.

What we are going to do in Sussex is a kind of compromise. For scientists, we propose to have a pretty general course embracing three sciences; at the end of three years there will be an honours degree based on that general course. If, beyond that, a man wants to be a specialist chemist or physicist or biologist, he will stay on for a fourth year and take another honours degree at the end of it in the single science. This would be confined to probably not more than about 30 per cent; it is one way of lengthening the course for those who need it most.

MR. HUGH CLAUSEN, O.B.E., I.S.O., B.SC.(ENG.) (late of the Admiralty): I believe I am right in thinking that Oxbridge has been throughout a lot of its history substantially a vocational training establishment for the more highly esteemed occupations. As long as the standards of relative esteem were largely determined by ex-Oxbridge graduates the matter was fairly simple; Oxbridge went on its way with a slightly dilettante attitude towards life; thinking that the national activities with which it did *not* concern itself were being properly dealt with elsewhere. In all the vast catalogue of the Great Exhibition of 1851, with which this Society had much to do, I think one would find great difficulty in discovering anything which was owed to university thought, tradition or background. The whole of the products exhibited there, including the building itself, were the work of another type of education—the old, personal master-apprentice relationship which has now to all intents and purposes disappeared. I think something very serious has been lost there, because up to the present nothing whatever has replaced that system.

If we are to survive as an industrial nation, the universities of the future must either pay attention themselves to the things which they now tend to contemn and despise as being technical or utilitarian, or they must give every support to the growth of new colleges of advanced technology to an equal level of esteem. So my question is, can the universities take a proper part in higher technological education?

THE LECTURER: This is partly a statistical question. I should have thought that the contribution of what one might call the civic universities to science, and applied science, was very great. (I am not going to speak for Oxbridge, as I taught philosophy at Oxford and therefore I may be thought to be vulnerable.) The university from which I have just come, University College, Swansea, during my time there swung its numbers from 50 per cent arts, 50 per cent science, to one-third arts, one-third pure science, and one-third applied science. I was very glad to have had a part in shaping that change and I am glad to see Professor Neal, who took a very great part in it, here to-night. I am a great believer in the non-vocational function of the university; but then I don't see why a lot of undergraduates in Engineering Departments should not take engineering degrees without being committed from the start to making engineering their life work.

MR. CLAUSEN: That is the whole point: engineering is being taught as a science, whereas it is an art, in which the eye, hand and brain must work in unison.

THE LECTURER: But it can be used to produce people who will turn to all sorts of work in the future without necessarily being professional engineers, and this seems to me to be very important.

DR. D. G. O. MORRIS, D.SC., M.I.E.E. (Reader in Electrical Engineering, Imperial College): I should like to ask Mr. Fulton's opinion on the principles which should govern the selection of students for universities. He has drawn a distinction between universities and professional colleges, saying that students in professional colleges have of necessity decided what direction they want to take in later life, whereas the students in universities have not necessarily done so. Now the division between the more able and the less able has little relationship to the division between the professionally orientated and the professionally non-orientated. What principles then should govern the selection of students, and what advice should be given to the young? In particular, when should the non-orientated be guided towards the professional colleges, and when should the orientated be guided towards the universities?

THE LECTURER: There must be many in this room who have had a great deal of experience in dealing with this problem in practice. I spend a lot of my life dealing with it. We, in the universities, are very tempted to make academic tests the test for admission, and there is no doubt a great deal of pressure to maintain that on grounds of equity. Judged by these standards, a very large proportion of the students select themselves, and I think probably select themselves rightly. The real problem of selection comes at the bottom of the list of those who are included and at the top of the list of those who are excluded. There the intellectual differences are very much smaller than they are between the top and the bottom of the successful list; and that is where the selector's judgement has to be exercised and where I think other than intellectual tests have to be called in aid.

I should guess that if you had been discussing this problem ten or twelve years ago, people would have tended to agree that most university failure was due to lack of brains. Now I think you would find that there is a pretty strong consensus of view that failure is very largely a problem of character, application, industry and motive. This becomes terribly important at the marginal point of successful entry if one is going to minimize tragedies and wastage. You have to take very seriously what the school says, and you have to do your best to judge whatever comes to light in an interview. I think you have got to do it this way and I think we have to admit that our judgements are fallible. We make mistakes, but I think there is no other way.

MR. E. R. TUCKER (Royal Grammar School, High Wycombe): Mr. Fulton paid a most moving tribute to the enormous value of a classical education and also to the great value of the tutorial system. Will there be no Honours school of classics in his new university?

THE LECTURER: I do not think there should be an Honours school of classics in the university now. The reason for that is partly that we have to order our affairs as well as we can with the resources we have got. We intend to have 3,000 students by 1970, which means that we shall have 300 members of staff, and we have to ask ourselves how they should be deployed to the best possible advantage. I do not honestly think, for example—greatly though I should like to have a professor of music—that I could really defend the idea of setting up a department teaching music for a degree in Sussex. I do not think one can defend the proposition that there should be a very expensive department of chemical engineering in every university in the country. One has to ask, looking at the country as a whole, what are the shortages? I am certain that there is a far greater shortage of opportunity for studying in what I call Afro-Asian fields than in the field of the classics. What I do want is to get people teaching, e.g., English, who read classics themselves and will guide students reading into the classical origins of European literature.

This is only one particular aspect of a very general problem. I have said something about the plans for the School of European Studies. We shall not, I think, go in for medieval studies for exactly the same reason as I have given for not having classics. Whether we shall stick to what we think now are the right subjects to have, I do not know. I think we can only look a reasonable distance ahead and plan in relation to what has greatest priority.

MR. L. H. ROBERSON (H.M.S. *Worcester*): What Mr. Fulton has said about the universities with regard to training students is excellent, but education implies a teacher. This is a side of the university which is so seldom discussed, and I think there is a growing feeling that the position where people who are concerned a good deal with teaching are appointed mainly on the results of research they have done is not entirely satisfactory. I should like very much to know what Mr. Fulton's views are on this. Perhaps I may offer a concrete suggestion: there might be something to be said, from the point of view of both schools and universities, if a few people were able to go on to university staffs after doing sixth-form teaching. There are, I think, many sixth-form masters who are still scholars in outlook but whose work has not allowed them to do research which might have qualified them for university posts.

THE LECTURER: I am Chairman of a body called the National Council for the Training and Supply of Teachers, and if I suggested that the universities were to rob the schools I think I should have to take refuge on the other side of the Channel for the time being!

I was aware that I did not talk very much about the teacher. I hope that we shall have many good people applying to us for our posts and I hope that we shall remain very firm that they must come prepared to teach the young. I am convinced that you can affect them enormously by teaching them in the right sort of way, by being the right sort of person and having the right attitude. We shall require those who want jobs from us to face the tutorial responsibility they will be undertaking. This will imply that we must look very carefully at the basis of promotions and so on. This in turn is a very big and difficult question. The organization of teaching in universities, other than Oxford and Cambridge, is on a national basis, just as the system of recruiting undergraduates now is; it is not just because of cussedness that the young man who is appointed to an assistant lecturership begins to think about his publications. He has got his eye on a whole system of university posts in other universities than his own: it is in that system as a whole that he looks for his career. It has to be admitted that publications in support of a candidature tend to be more easily assessed

than subjective judgements about teaching ability. I have to confess that here we have a very difficult problem for which we must find a solution.

MR. J. GWYN MORGAN (President, The National Union of Students): Mr. Fulton's thesis about university education seems to me to perpetuate a clear demarcation line between universities and other institutions of higher education. I think I would be prepared to concede that this is in the best interest of universities, but I should like to ask Mr. Fulton whether he thinks it is in the best interest of the nation?

THE LECTURER: I do not know that you would be entitled to draw conclusions about my views on this. I think this is a question that we have all got to address ourselves to. All I felt it my obligation to do was to try and make clear what it seems to me a university ought to be trying to accomplish. If other bodies can do it too, they can claim to be universities also. The essential prerequisite is to be as clear as possible about what we as universities are trying to do. That was my only object.

MR. ALAN HALE, B.SC.(ECON.) (Student Secretary, National Union of Students): Having had a very stimulating glimpse of the plans Mr. Fulton has for Sussex on the arts side, I have been waiting, in view of the problems of higher economic and scientific education, to hear some comment from him—I hoped in answer to other questioners—on his plans for scientific faculties.

THE LECTURER: Well, science is very much less forward, but we have got certain general principles accepted. First of all (taking the sciences in the conventional sense), we are committed to a general science course, to be followed for those who are suited to it and who want it, by a specialized one-year course; both of them leading to Honours degrees. We intend also to organize the sciences by schools, as we are doing in the arts faculty. This is the barest outline.

We would also hope to do something to break down barriers. There are quite obviously existing bridges between arts and science, and there is no reason why these bridges should not be strengthened and people encouraged to cross them. You will remember, however, that there has not been great alacrity on the part of the student to cross these bridges when they have been provided; you can contrast, for example, the relative demand for P.P.E. and for the School of Philosophy, Psychology and Physiology at Oxford. I take the view that the final test of courses is whether people want them. We can devise all sorts of ways of taking them to the water but it is still necessary to discover if they want to drink. (I ought to have said, too, that we are going to have biological science as a school without the ordinary divisions into zoology and botany; it will have a number of professors, but not attached in the present way to the conventional division of subjects.) We propose to have a school of engineering science lasting three years, and it will not be engineering in the specialized forms of electrical, mechanical and civil. From that again people will, I hope, go on, to their specialized course. This is again a bridge which can be built between us and the colleges of advanced technology. Our students will go to them for the specialized kind of engineering course they can offer. These are the very rough outline plans for science, outlines only, since they will be a year behind the arts. We are starting two years ahead of the original programme; to do this we have hired premises in which to teach the arts students in the first year; since we cannot hire premises with laboratories, we shall have to be content to start science a year later.

THE CHAIRMAN: There are various criteria that can be used to distinguish an admirable lecture, but certainly one of the very best is the way in which it stimulates questions. Your questions have been numerous and they have indicated your interest both in the subject of the lecture and in the way the lecturer has put his case. I would ask you to make that interest and pleasure quite explicit in the ordinary way.

The vote of thanks to the Lecturer was carried with acclamation and, another having been accorded to the Chairman upon the proposal of Mr. A. R. N. Roberts, a Member of Council of the Society, the meeting then ended.

HUMAN PROGRESS AND ECONOMIC GROWTH IN THE DEVELOPING COUNTRIES

A paper by

M. G. IONIDES, B.A., A.M.I.C.E.,

delivered to a joint meeting of the Society and the Chadwick Trust on Wednesday, 17th May, 1961, with Sir Allen Daley, M.D., F.R.C.P., Chairman, The Chadwick Trustees, in the Chair

THE CHAIRMAN: My duty as Chairman is very simple and comprises two main points only. First, to emphasize to you the importance of the subject of the lecture, and secondly to mention the qualifications of the lecturer for dealing with the subject.

An enormous amount of thought, manpower and money is being devoted by the well developed countries to those countries which are developing, and it is essential that we should understand the problems and provide assistance where it is most needed. We are fortunate in having Mr. Ionides to expound the problems. He is a development consultant and has held official positions in Transjordan and Iraq, and has more recently worked in association with the Food and Agricultural Organization on land and water problems in Somalia and in the Sudan. We are to hear a discourse by one with unique practical experience, which I would suggest to you is much better than having one who has simply text-book knowledge and has been mostly desk bound.

The following paper, which was illustrated with lantern slides, was then read.

THE PAPER

It is nowadays customary to say that plans for developing the poorer or emerging countries should pay more attention to the human resources as well as the physical. This is not to say that western theories and policies have neglected the human and social aspect of affairs in these other countries. There are the United Nations specialized agencies such as the International Labour Office, the World Health Organization and the Food and Agriculture Organization, proof enough of our concern for people's well-being. The United Nations Special Fund is founded on the idea of fertilizing the grass-roots of society. There are other multilateral organizations and many countries have official agencies for giving technical aid. We in this country are to have a Ministry for that purpose, and large funds have been made available through the Colonial Development and Welfare Acts, Colonial Development Corporation, our share in the Colombo Plan, and through private enterprise. There is the Community Development movement. There are the Churches and the Missions, the overseas voluntary service organizations in this country through which volunteers in plenty can find an outlet. There are the great charitable trusts and foundations in America. As if to remove any

doubts about our good intentions, we proclaim them every hour of the day through radio programmes in every language, reaching the remotest ears in the remotest corners of the bush, the forest or the desert.

Yet in spite of all this and in spite of the vast sums of capital loaned or given for development projects, it can still be said that the gap between the rich and the poor in the developing countries is widening rather than narrowing.

Why should this be so? It would be presumptuous for me to suggest that in the brief time before me I could attempt to diagnose all the reasons, still less propound a cure. What I shall try to do is to take one limited aspect of development in the context of an imaginary emerging country, and construct from it a comparative analysis of two very different approaches towards programmes of capital investment, from which some clues can be identified.

Let me first define my limits more closely. People need education and training, health and other services which we think of under the heading of welfare. These are all outside the scope of this paper, not because I place them secondary in importance, but because my time is limited and so my subject must be circumscribed. Here we shall be concerned with the physical environment in which men live and produce food to eat, water to drink, houses to live in, clothes to wear, tools to work with. We are concerned with capital investment in items of equipment ranging from water-wells, houses and drains to hydro-electric dams and irrigation projects, from village workshops and brick-kilns to canning factories and steel mills; with all those things which men build by hand or machine and put to use so that they live better and produce better.

As a model for our analysis, let us consider an imaginary country called Sigmaland, whose name implies that it has already advanced a good way along the alphabet of change from the state of primitive exclusion, but still has far to go. Three different sectors can be distinguished in the structure of Sigmaland society as it relates to our subject. First, there is a large 'subsistence sector'. The people in this stage of evolution eat most of what they grow, and sell only a small margin to the market. They use the money they get to buy things like tools and clothes, pots and pans, sugar and tea. They may save money too, and keep it against a rainy day—or perhaps I should say a 'dry day', because water supply is so often a crippling difficulty. But they do not use money as a means of capital accumulation in the economist's sense. They do not, in particular, use their savings to employ other people to build their houses or huts. They build them with their own hands.

In terms of advance in the institutions of society, I put this question of building houses and the communal amenities in a very special position because I cannot imagine any significant improvement in the standard of life which does not include noticeably better homes and villages. I cannot imagine how this can happen unless the people apply their own industry and labour, using the materials which are around them to build better houses and villages for their own families to live in. Nor can I imagine how this is to be done unless there is a division of labour between those who produce food to eat and those who build houses to live in and make the building materials from which they are constructed. Therefore the evolution of identifiable building and building materials industries, as part of the

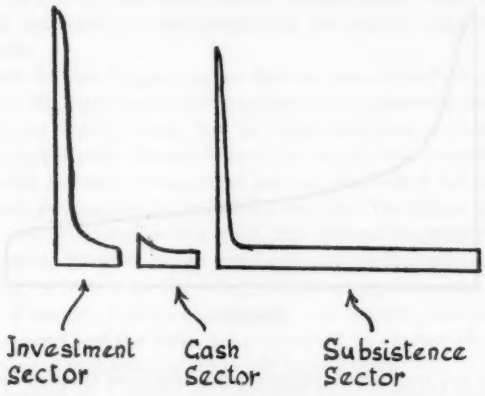


FIGURE 1

structure of rural society, is a fundamental step in transforming the subsistence sector into a more advanced state. Building is the basic industry of all industries.

The second division of society is the 'cash sector'. This sector includes such people as the smallholders who live by growing cash crops of all kinds which they sell in the markets, handcraftsmen, and the small shopkeepers. Most of the income of people in this sector is in cash. Typically they pay other people to build their houses and to this extent they use money for capital accumulation. But they still belong to the 'muscle-driven' stage. Their prosperity depends on their own personal skill, diligence and bodily strength. In common with the subsistence sector, this cash sector comprises people whose way of life has not yet been transformed into the still more advanced pattern of mechanized economic civilization.

Thirdly, there is what I shall call the 'investment sector' of the community with its familiar institutions for commerce, finance and industry. In the cities and towns the people in this sector run the factories and the stores, the commercial houses and the banks, the cinemas and the printing presses and the radio stations, the water works and the power plants. In the countryside they run the capitalized and mechanized farm estates and plantations, the mines, the timber yards and the saw mills; they operate the ports and railways, airlines and telephones. In this sector, income is exclusively in the form of money, and the only people in it who still build their own houses with their own hands are those poor, uprooted people in the shanty towns round the cities. They are in but not of the investment sector. They work for wages and wages are their entire means of livelihood. But they have brought with them from the countryside out of which they drifted the simplest institutional customs.

Sigmaland's material resources can be summarized as follows. There is a large region enjoying enough rainfall to grow crops, with a dry season in which water

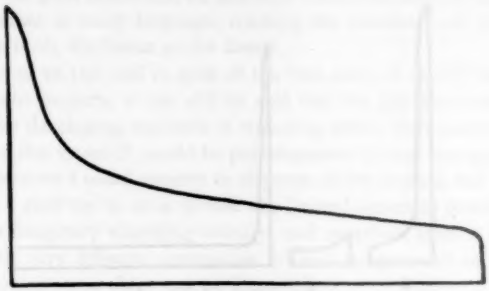


FIGURE 2

is scarce. There is a river which irrigates substantial areas through long-established indigenous canals both in the hills and in the alluvial plains. The subsistence population are partly semi-nomads living off livestock which roam the natural grazing; partly shifting dry-farmers; partly settled dry-farmers; and partly irrigation farmers. There are some sophisticated irrigated estates growing high value cash crops, mainly for export; some well-run capitalized farms in the dry farming area cultivated by machines; and some up-to-date cattle ranches launched and financed by enterprising men from the cities. There are resources in land and in its potential productivity which could support a much greater and more prosperous rural society—there is no absolute pressure on the agricultural resources. Then there are mineral deposits of considerable importance favourable for export development, given finance and proper management, and sea fisheries. There are materials for making artificial fertilizers. In addition, there are considerable potentialities for industrial development, both for saving imports and for the export of various goods produced from local resources.

We can illustrate these three sectors of Sigmaland society as in Figure 1. This is an 'impressionist' diagram, without scales, to display the following points. In the investment sector there are quite a lot of rich and well-to-do people, as is indicated by the pinnacle of the figure, and also a lot of poor people who are mainly wage-earners. In the cash sector, on the whole, none are very rich, but none are very poor. In the subsistence sector, there a few wealthy people who are mainly the tribal leaders and notables whose wealth tends to be in kind and position rather than in capital as it is understood in the economic investment sector, while the rest are more or less equal in material well-being.

By contrast, let us consider Figure 2. This represents (also in an impressionist manner) a prosperous country of the same population as Sigmaland, but near the richest end of the alphabet of development—say, Gammaland. The transformation to the investment system is complete. There is no subsistence sector left and the cash sector remains only in a few vestiges. There are very few people left who are not literate. Most people understand what it means to buy stocks and shares, through which they can enjoy part of the profits of enterprises that they have

never seen, never will see, and know little or nothing about. There are also some very rich people and some very poor people, but the nation's wealth is in the body of the community.

If we compare the two Figures, we see that the area of the former is much less than the area of the latter, which is a graphical way of showing that the average annual income per head is much less in Sigmaland than in Gammaland. But notice that the upper parts of each Figure are on par—the investment sector of Sigmaland society belongs to a universal pattern, interlinked and interlocked by channels of trade, finance, culture and official dealings. The disparity in well-being is not between the two countries as a whole, but between the people of the investment sector in both countries on the one hand, and the Sigmalanders in the cash and the subsistence sectors on the other. But knowledge is spreading fast in the latter sectors of society. Increasing education and literacy, wide-ranging means of travel, the cinema and the radio, have combined to implant all round a desire for the enjoyment of well-being which is still beyond reach.

Taking Sigmaland as a whole, the statistics show a steady increase in prosperity as measured by the usual indices. But since rather more than half the population still live in the subsistence sector, the increase in the country's wealth tends to be concentrated in those geographic areas where the economic system is most fully at work; namely the cities, the estates and the industrial zones. It is true that the people in the subsistence sector can enjoy some of the most highly sophisticated end-products of technological civilization in penny numbers—a ride in a 'bus, a trip to the cinema, a radio set. But their domestic circumstances, their houses, their villages and surroundings, their water supply and sanitation, have hardly changed at all. To the extent that modern civilization has impinged upon them, it is in those manifestations which stimulate the mind while doing little to feed, clothe or house the body. The revolution of rising expectations is in full swing.

Let us imagine that the Government of Sigmaland wishes to formulate a development policy and plan, and that they invite two separate teams to investigate and report separately. The teams are set to work and their plans take shape as illustrated in Figures 3 and 4 (pp. 862, 863). For the moment, I shall call them Plan A and Plan B.

The Figures show, in outline, what the investment works in the two programmes are to be according to the two plans. I am not now concerned with their rival merits. All that matters for the moment is the evident fact that they are very different, and that the reasons why they are different is that the systematic approaches of the two teams are different and therefore lead to different results. The two start by asking quite different questions. The Plan A team first ask: 'What are the resources which are *not* being used now, and what can be done to exploit them?' The Plan B team ask: 'What are the resources which the people *are* using now, and what can be done so that they will use them better?'

Since the A team are looking for resources which are not now being used, it follows that they look in places where people are not at present occupied. The projects in Plan A are capital investment enterprises to be newly built, on new locations to which people must migrate in order to provide labour, moving away

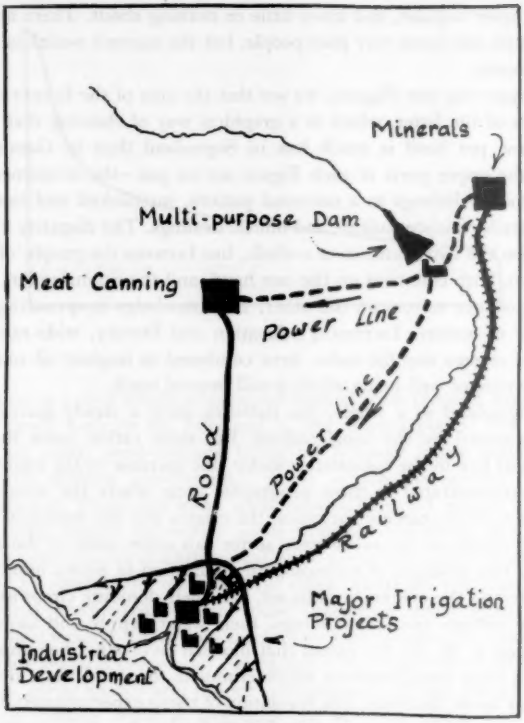


FIGURE 3. *Plan A*

from wherever they are now. The new irrigation systems to irrigate land at present uncultivated, the new mines and quarries, the new power stations, factories and other industrial plant, all require men, and therefore men must move themselves to the projects. Each project in Plan A represents an item of economic growth. This capitalized and mechanized sector of society will grow statistically under Plan A, but it stands apart from the subsistence sector because it is in geographic locations of its own, and is separated also by the human boundaries which divide society into sectors. The investment sector grows, so to speak, in parallel with the existing social structure of the countryside. People move physically out from the rural subsistence sector, and into the investment sector, but the subsistence sector from which they move stays much as it was. The people are transferred, but the subsistence society is not transformed. On the contrary, since Plan A concentrates on the most directly profitable types of investment, creating a demand for all the available educated and enterprising Sigmalanders to construct and operate the new projects for economic growth, there is a specific magnet drawing their talent and their attention away from the subsistence sector and its problems.

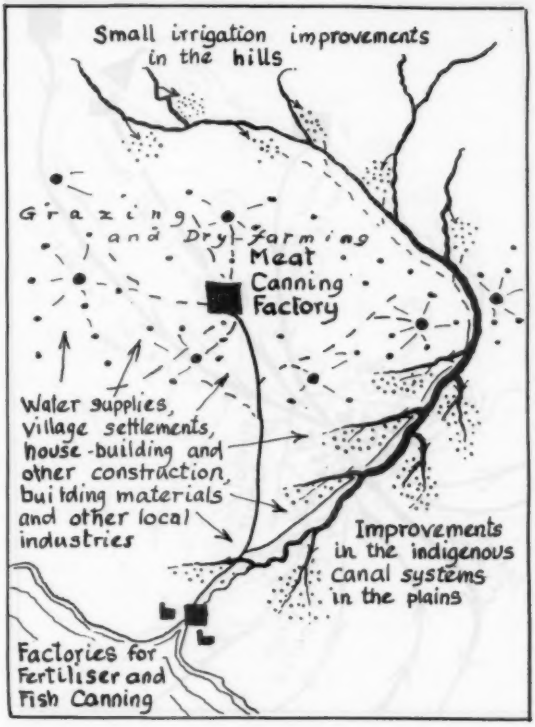


FIGURE 4. *Plan B*

Now consider Plan B. The first question this team asks is: 'What resources are the people using now, and how can they be used better?' Therefore inquiries begin by sending surveyors of various professions in amongst the rural communities as they are now, to ask questions and gather facts. The team does not arrive with a blueprint showing what life for the Sigmalanders might be like if only they had the means to reach it; they go in to find out what life actually is like now, and then look for ways of making it better.

The Plan B team regard it as an essential to facilitate a transformation from the subsistence system towards a more prosperous manner of life, and they pin-point two fundamental objectives. First, rural productivity must be improved. Second, the basic division of labour must be promoted through which the building industries emerge as part of the structure of rural society. By definition, I have limited the scope of this analysis to items of capital investment, so the Plan B team search for practical works which can be listed, made into a programme, specified, ordered and executed.

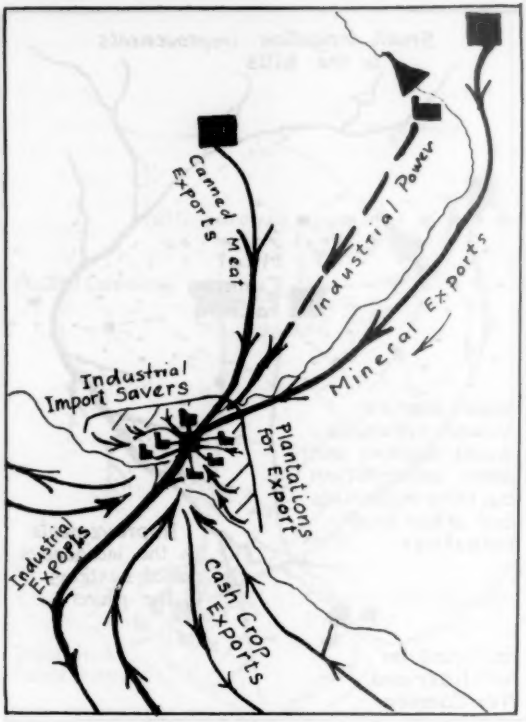


FIGURE 5. *Plan A* (*see p.* 867)

In the areas where there are semi-nomadic livestock raisers and shifting agriculturists, the plan includes works to provide adequate and secure supplies of sound drinking water, as a first item. This is not only for motives of welfare or as a social service or a health measure. In this simple rural society, water to drink is one of the prime factors of production, along with the land itself and the men with their brains and their hands. When pure water is provided so that it is plentiful and ready to hand where the men work and the beasts graze, an otherwise insurmountable barrier to better productivity is removed. Wherever good water supplies are provided in these areas, human settlements begin. Before long there are shops, and then a market comes to life.

The B team aim to take advantage of this spontaneous reaction so as to guide the layout of the new villages and towns as they grow. They also plan to promote use of the local resources for building materials, to improve construction methods, and to train the young craftsmen. As the transformation into the cash system begins and the critical turning-point is reached when men begin to employ others

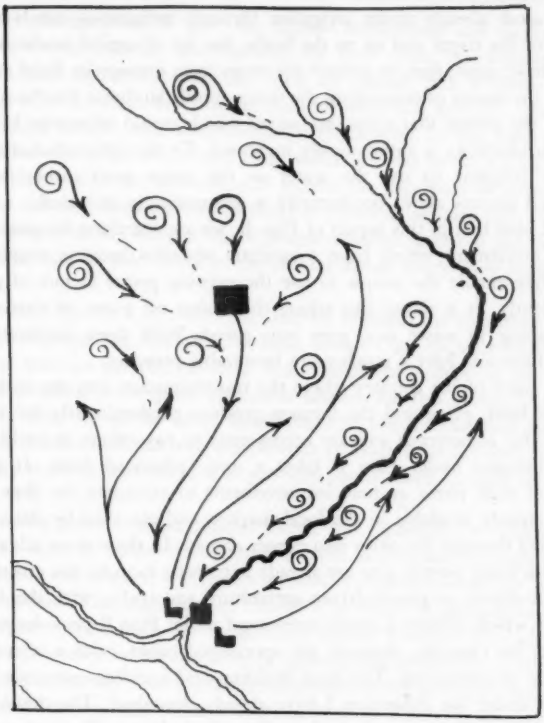


FIGURE 6. *Plan B* (*see p.* 867)

to build for them on payment in cash, the standards of construction will therefore be improved, and the local building and materials industries will be fostered.

To provide positive impulses, establishments for research and development into the production and uses of local building materials are created. These materials are the local woods and reeds and grasses, the local stones, clays and other deposits and all that can be made from them. The services of the most advanced centres of technical research are brought to bear. Specially designed items of plant suitable for the local materials and within the competence and comprehension of the people are developed, with the help of the appropriate industrial drawing offices and laboratories. This team of men is not at all interested in improvisations. They are not trying to perpetuate or revive the rural arts and cottage industries and crafts of a bygone age, nor are they aiming at self-sufficiency as a matter of principle. What they are after is improvement by a synthesis of all the best of the local skills and initiatives and the best of local materials wherever they will answer the purpose, together with the best that all the resources of modern technology can add.

In the areas already under irrigation through indigenous canals which lead water out of the rivers and on to the fields, the list of capital works is chosen to serve two basic aims; first, to protect the crops from damage by flood, and second, to provide the means of controlling the water supply so that it fits the needs of the crops. To the extent that crops are saved which would otherwise be destroyed by flood, productivity is automatically increased. To the extent that control works enable the irrigator to use the water as the crops need rather than as the uncontrolled sources allow, productivity is automatically increased.

You will note that in this aspect of Plan B, we are searching for practical works of capital investment which have a catalytic stimulus because simply by their presence they enable the people to use the existing prime factors of production more efficiently. It is rather like taking the brakes off a car, so that the energy which is going to waste now goes into speed. With these improvements the agricultural services have a much more favourable prospect.

In those parts of the country where the transformation into the cash economy has already taken place and the farmers produce predominantly for the market rather than for subsistence and are accustomed to pay others to build for them, capital investment under Plan B takes a more advanced form. It puts more emphasis on such items as road improvements to stimulate the flow of goods which are already available in the local markets and can thus be drawn towards the cities, and through the cities into export abroad. In these more advanced areas there are also many people who are already beginning to make the critical advance from muscle-driven to power-driven agriculture and crafts, with the increase in productivity which follows. Capital investment under Plan B provides support for this change; for example, through the specialized banks, with a selective policy to encourage co-operatives. The local building and building materials industries are brought under the influences I have already described. The development of towns and villages is encouraged along lines laid down. The government and municipal construction departments can begin to put the locally produced materials into their designs as soon as proper specifications have been developed. These standard specifications, with the capital investment in the research and development which leads to them, can be most fruitful. If they do not exist, the architects and engineers cannot put them into their designs, the extra stimulus from construction programmes will not be exerted, the demand will not be generated, the local factories will not be built, and a lot of materials which could perfectly well be made in the heart of Sigmaland will have to be imported.

Plan B includes several large-scale industrial establishments—it is by no means only concerned with the multiplicity of small works in the countryside. There is a fertilizer factory, for example, a fish-canning factory and a meat-canning factory. These also appear in Plan A, and to look at them you cannot tell which plan they belong to. The difference is in the radically different way they are used. The A team want the factories to be individually profitable and hope to attract investment capital from abroad, whether from private sources or in the form of bilateral aid from some friendly government, or from the International Bank. Therefore they aim at the most directly profitable export markets. The B team on the other

hand want the factories to have the highest stimulating and catalytic effect on Sigmaland's own internal development. In their eyes, the fertilizer factory is associated with agriculture, together with an organic link between the lines of distribution for fertilizer and the agricultural extension services. The profit they have in mind comes from a simultaneous fertilization of the roots of the crops and therefore the roots of internal trade which accrues as extra produce flows up from the fields into the markets and fattens the tap-roots of commerce. They regard the fish and meat canning factories as a complementary pair, for the canned fish can be sold in the interior where people produce meat but not fish, while the canned meat can be sold down in the coastal towns where they produce fish but not meat.

In terms of the cycle of trade, the contrast between the two plans is shown in Figures 5 and 6 (pp. 864, 865). Plan A looks towards the cycle of trade which links Sigmaland with the external markets. It considers the interior of the country as a source of produce for export, and as a market for the products of industrial enterprise. Plan B, on the other hand, looks to the internal and local cycles of trade first, those which link the people who produce food for their neighbours of the locality to those who build and produce goods made in local workshops and factories.

To put this point in more general terms, the yardstick for capital investment under Plan A is in terms of economic growth as revealed through the statistics of production and export, and in the growth of capital investment in relation to national income. The yardstick for Plan B is in terms of advance in the development of rural society from the subsistence system through the cash system and onwards, as revealed by the statistics of agricultural production and productivity, with the help of indices showing the development of the primary capital equipment of human settlements, and of the industries through which the physical equipment of these settlements is produced.

The analysis has now brought us to the stage of symmetrical comparison between the two plans, and it is helpful to symbolize this comparison by means of Figure 7 (p. 868). I have labelled Plan A the 'economic' plan because it is derived by processes which are customarily used in framing economic plans for developing countries. As the Figure indicates, the initial question by this process concerns the physical resources. On the other side of the Figure, I have called Plan B the 'ekistic' plan, which starts its initial inquiries by asking questions about where the people are living now and what they are producing, that is, about the human resources. Some general name for the processes of Plan B is needed because they are significantly distinctive, and because if we are to go on into more general discussion, we must dissociate our thoughts from the particular and imaginary circumstances of Sigmaland and its Plans. I use the word 'ekistic' because it is already coming into use and is appropriately applied in this context. The word was coined by Dr. Constantine Doxiadis, and his own definition is as follows: 'It comes from the Greek verb οἰκῶ, meaning settling down, and demonstrates the existence of a science of human settlements conditioned by man, influenced by economics, sociology, geography and technology.' Incidentally, Dr. Doxiadis

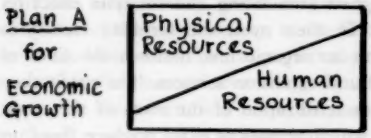


FIGURE 7

was the moving spirit in the foundation of the new Athens Technological Institute, where ekistic science is under active study. I gratefully acknowledge my debt to Dr. Doxiadis and his associates, and the stimulus of close co-operation with them for several years in their pioneering work on these studies.

The arrangement of the two 'wedges' in Figure 7 signifies that although the economic and the ekistic approaches start respectively from the consideration of the physical and the human resources, each item in each programme needs to be looked at from both points of view. I have truncated the wedges at their sharp ends, so as to remind us that there is no item of capital investment which can be regarded as exclusively ekistic, and none which is exclusively economic. In other words, the ekistic team must have economic advice, and the economic team must have ekistic advice. I mean also to illustrate that economics and ekistics are complementary, not opposed. Both the economic plan and the ekistic plan I have discussed are plans for capital investment having as their aim an increase in the material prosperity of the people.

The case of the factories for fertilizer and canning can be conveniently thought of as being situated mid-way between the ekistic and economic boundaries of the symbolic diagram. The economic and the ekistic content of the projects are in a kind of balance because although the purposes for which the factories are to be used are different, the factories themselves are identical. We can also construct cases where the converse holds; namely, where the purpose is identical but the physical construction totally different.

For example, one way of providing pure water for a village is to employ engineers with instructions to frame standardized designs for building waterworks exclusively from raw materials which are available in the locality of the villages, calling for labour and skills which are also available among the people of the villages. In addition, so as to make the maximum use of local labour, the construction programme is to be adjusted so that the labour demand comes during the seasonal periods of underemployment.

An opposite solution goes to the other extreme. Engineers are instructed to provide a water works to yield exactly the same supply of pure water as the former design, but by means of a plant which embodies a minimum of local materials, local labour and skill. This will be a 'packaged' plant, fabricated in an industrial establishment far away which is crated, carried to the site in lorries, installed by skilled men who come with it, do the job and go away.

In the first case the design might be said to have an 'ekistic coefficient' of 100 per cent, while in the second this coefficient is zero. This is illustrated in Figure 8. Thus while the purpose of the water works itself is identical (to supply a specified yield of pure water), the works themselves are totally different; to look at, in the

manner of construction, and also in the side-effects of the processes of construction. I have chosen the extremes of 100 per cent and zero illustratively. The practical range of choice is clearly narrower in practice.

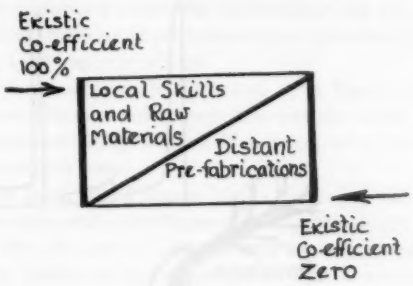


FIGURE 8

It is not difficult to imagine that the cash which has to be paid might be the same in either case. Regarded as an item in the accounts, the two may well appear to be identical—so much money spent to provide a water works which will do a specified job. But this apparent identity in terms of monetary cost conceals the important fact that if the ekistic coefficient is zero, practically all the cost will have to be paid for out of foreign exchange, while if the ekistic coefficient is 100 per cent, the whole process of construction and every item of monetary transaction take place in the closed circle of the locality itself. The availability of designs and specifications with a high ekistic coefficient therefore enables village water works to be provided which Sigmaland could otherwise not afford to have at all. The same considerations naturally apply to constructional designs for other purposes.

Another symmetrical contrast can be seen in the plans for irrigation development according to the economic and the ekistic plans. In the economic programme, which includes projects for new canal systems irrigating new land at present not cultivated, the economic profitability can easily be calculated and related to capital cost, by estimating the yield, the prices and the markets. But in fact there are substantial elements of capital cost which are seldom included in the direct estimates. These are the cost of building new villages and towns, buildings for government administration and services, the roads, telephones, water works, power plant, etc., and also the very substantial capital investment in the effort needed to move people from wherever they were before, and settle them in the new areas. A completely new 'going concern' has to be constructed, which costs money. Under the ekistic plan, on the other hand, the improvements are spread out within a structure of society and administration which is already a going concern, together with its physical and human apparatus.

In general terms: if the new irrigation projects in the plan for economic growth are judged by ekistic criteria, items of capital cost to the community will be included which the economic criteria omit to take into account; while conversely, if the irrigation improvements in the ekistic plan are judged by the economic criteria, items of profit to the community will be omitted which the ekistic criteria include.

I must go back now to the point at which we started, which was that the Government of Sigmaland had before them two plans for capital investment, which we now recognize as being a plan for economic growth on the one hand, and a plan

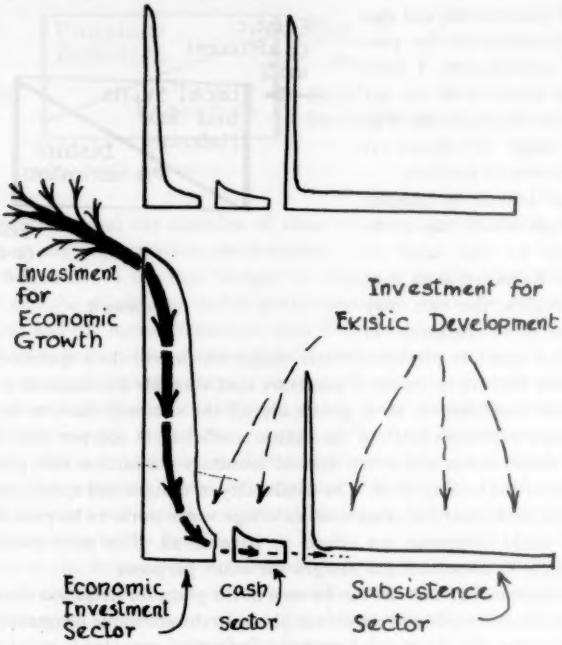


FIGURE 9

for ekistic development on the other. My own advice to the Government would be to put the two teams together and tell them to work out a sensible mixture within the country's means, because what Sigmaland needs is both economic growth and ekistic development.

But suppose the Government do not call for an ekistic plan at all, but only a plan for economic growth, what happens then? What happens is that if they adopt a plan for economic growth, they will get economic growth; while if they do not invest in a plan for ekistic development, they will not get ekistic development. The result will be that people in the subsistence area who have been to school, listened to the radio and seen the films, will move off into the towns and cities, and to wherever the programme of economic growth implants enterprises such as factories, mines, power stations, plantations or new irrigation projects. Therefore, talent and initiative will be withdrawn from a rural society which is already relatively falling behind, and which (by definition) is not under the stimulus of specific plans for ekistic development. Health measures for man and his livestock will cause the population to rise, and therefore to press upon sources of food which, although improving somewhat under the stimulus of agricultural services, are relatively stagnating. Since the staple foodstuffs on which the whole of Sigmaland

relies are produced in the neglected subsistence sector, the Government will now face the awkward situation that a country which is still predominantly an agricultural producer is on the way to becoming a net importer of food.

The general effect on the flow of investment can be illustrated as in Figure 9. The direct influences of the programme for economic growth flow into the investment sector of society. The subsistence sector lags behind. If more capital of the type of Plan A is injected, the imbalance gets worse.

The comparative analysis in this paper is of course highly simplified and exaggerated. I do not know of any country with a development programme devoid of ekistic content in the manner of Plan A; nor do I know of any country where a development programme so rigidly limited to ekistic items as in Plan B would make sense. I am sure there are some countries where a fair balance is maintained. Moreover, in order to focus attention the more sharply on items more directly related to production, each of my illustrative plans excludes many items which are always to be found in development plans, such as schools, hospitals, dispensaries, clinics, etc. Nor should it be supposed that the analysis I have presented spans all the studies which can properly be considered within the range of ekistics. I have cut a slice out of the cake of ekistic thought, so as to see what it looks like inside, but no more.

Nevertheless I submit that my analysis lends support to a general proposition which might be stated as follows: the sciences which we teach and practice in pursuit of economic growth do not cover the full needs of the developing countries. We therefore need to identify, teach and practice a parallel science in pursuit of that distinctive type of development which comes within the scope of ekistics.

Naturally it is the responsibility of the government of each developing country to work out its own plans. In this direct sense, the responsibility is not ours but theirs, and it is for them to choose. All the same, we cannot escape those indirect responsibilities which lie upon us because of the fact that it is very largely from our teaching and our practice that the governments of developing countries derive their methods and criteria for planning and development. Moreover, we also have a very direct responsibility for the pattern of policy which is implicit in the organizations and processes through which we provide technical and financial aid, by which the impress of our way of thinking is laid upon the recipient countries.

In consideration of both our direct and our indirect responsibilities, I believe we ought to review our teaching and our practice and adapt them so that they will lead towards a more productive balance between capital investment for economic growth and capital investment for ekistic development.

DISCUSSION

MR. HERBERT ADDISON, O.B.E., M.I.C.E.: Since we are talking about Sigmalians, an imaginary people, could we ask why they want any developing at all? Is there something special about the circumstances of the country of Sigma which requires development? Also, would it not be better if Team A were required to select Team B from people living in the country of Sigma because they know more about the country concerned?

THE LECTURER: First, why do Sigmalanders want anything done at all? Well, they have been told over the radio that they ought to do something for themselves and that there are big brothers from various countries to help them. They feel development is a thing they ought to have and the better educated amongst them realize that something has to be done. They realize that their own society cannot be left as it has been through the ages, in circumstances where the radio, motor cars and other things are bringing to the people at large knowledge of what life could be like. At any rate I do not think it can be disputed that most of the countries we call underdeveloped do want to be developed.

As to the sort of people to put in Team B, the answer to that is that at the present moment I would have great difficulty in finding them, because unfortunately most of our technical experts and economists have been trained for Team A and not for Team B. It is quite easy to find technicians and contractors for big projects. It is very difficult to find people interested in such things as small-scale water supplies in villages.

The mere fact that I introduce 'ekistics', a word which is as yet unfamiliar, indicates that there are not yet many people who are trained in this kind of approach to development. So long as we impress methods of teaching which do not include this ekistic aspect of capital investment, the natural instinct is towards the most immediately profitable ventures, and this leads away from ekistic development.

There is another point: on the purely technical side of designs and specifications for promoting rural industries and building work, progress of the kind I have described requires adequate command of all the resources of industrial technology, research and development, which most underdeveloped countries do not themselves possess. That is why I stress that the ekistic way is to make a synthesis of the best that is there and the best that comes in from outside. I would see no point in leaving the Team B selection solely to the people of the country; they know more about their own country, but they need imported technology as well.

SIR SELWYN SELWYN-CLARKE, K.B.E., C.M.G., M.C., M.D., F.R.C.P.: I think we should all agree with the speaker in his conclusion that much more thought should be devoted to assistance in the way of colonial development and welfare. Where I am inclined to disagree with Mr. Ionides is in a fundamental matter. It seems to me that the people concerned with Plan A were trying to devise methods for exploiting local resources not for the benefit of people of the country but for the benefit of those countries whom they represented.

Let me give you an example. In the country where I worked many years ago, our geologist discovered manganese. Manganese was of no use to the people of the country, in that form, but it was vital in connection with steel production and shipbuilding in this country. In the same way, when commercial diamonds were found, they were of no benefit to the people of that country but they were of great value in connection with our machine tool industry. Of course these materials did bring a certain amount of financial return to the country concerned, but fundamentally it was our needs rather than those of the people that was the overruling factor. In the same country when gold was developed, I did not think it brought any happiness to the people. It did, however, detribalize a large number of labourers who were housed under quite appalling conditions, and who developed chest diseases of various sorts, including tuberculosis, until the Government brought in mining health regulations to compel a better standard of housing. Mr. Ionides seemed to suggest, to my way of thinking, that in the ekistic development there was no question of economic growth. He gave an example of a canning factory in a meat-producing area and a fish factory on the coast. That surely was a form of economic development which benefited the people of the country?

THE LECTURER: In any bilateral relations between, say, this country and an

undeveloped country, whether they concern investment by a commercial firm or aid given by our Government, it follows inescapably and properly that the people who give the aid have our economic interests as well as theirs at heart. I do not see how it can be otherwise. When the British Government offers a grant or loan to an undeveloped country, it is responsible to the British Parliament, answerable to the British people. In other words, in this kind of bilateral relationship I do not see room for a completely disinterested gift or grant of aid, and I think governments make a mistake in trying to present these things as if they were disinterested, because the other people are immediately suspicious.

Most of the major investment projects such as I have outlined under Plan A—the canning factory, the meat factory, mineral investment—are by nature things which require some kind of foreign involvement, and the attraction to the aiding or the investing agent, whether it be government or private interest, must necessarily be a commercial one. What I regard as unwise is to promote that kind of economic growth while not promoting investment in ekistic growth. One can draw a parallel here between what happens in a single country and what is happening internationally. In the England of free enterprise Government says in effect, 'All right, go ahead, make as much money as you can, but we are going to take some off in order to provide water, public services, welfare, all the things that even out the social balance'. In the sphere of aid to the underdeveloped countries, disinterested help comes mainly on to the international plate, because the international agencies are those agencies in which all governments have representation, and the agencies can truly say they have no national interest. But we have not yet got the machinery to ensure that the flow of capital aid is properly balanced between investment for economic growth and investment for ekistic development.

On the second point: many of the things in an ekistic programme obviously add to the economy of the country. The point about the ekistic programme of development is that it starts at the bottom of the scale where you are dealing with works which are usually regarded as being 'non-economic' and as associated with social welfare, and with the idea of giving something to somebody for nothing. The point I have tried to make is that there is a whole class of ekistic investments which are also concerned with production but are unattractive in the investors' sense because there is no revenue which they can identifiably set against their investment. The characteristic type of capital investment for ekistic development is that which is profitable to the community as a whole, but unprofitable to the single investor and therefore unattractive to foreign sources of credit.

MR. C. P. M. HUNTING: There is one point which seems to occur in all these discussions on economic aid programmes: that is, how difficult it must be for an ex-colony that has had its reins of government held by a special group of officials from the Governor down to its provincial and district commissioners, to stand up on its own. Most of the European skills have got to be replaced and they won't yield 6 per cent in themselves or anything at all in the long run. It seems to me that there must be some longer-term aid that could be given for the replacement of those skills—starting with aid for education. I do not believe it is a matter of thinking out schemes for cottage industries, but partly a question of studying, on your Team B principle, the methods suitable for building, say, houses or dams under small-scale schemes in villages in emerging countries where first things do not happen always to come first.

THE LECTURER: There is no doubt that the D.C., being a man whose heart was traditionally and very truly with the people of his district, did an immense amount to stimulate the kind of work which the rural people of the country don't naturally think of for themselves. A man of the country may become District Commissioner, and do the job very well, but he cannot be the same thing. Whereas the typical

District Commissioners combined educational, social and to some extent technical influences, I should think that when the change happens and life in the countryside gets more complex, these functions have to be split and departmentalized.

But from the countries that I know and worked in, I have little doubt that a great deal could and would be done as regards the physical circumstances of life with a little bit of ekistic capital investment: with capital investment in establishments for research and development of ways and means of promoting local skills and materials. It has been done in some places. It can be reduced to a systematic series of steps of research, development and application. Of course it has its difficulties, and although I said in reply to Dr. Addison that there would be a difficulty in finding people I do not think it would persist once there was an initiative and guidance. At the present moment we have in this country no funds to provide for initiative of that sort; nor is there an international agency, except the United Nations Fund, which has funds which can be used in this way in particular cases.

DR. R. S. MILLARD (Road Research Laboratory, D.S.I.R.): I was intrigued by Mr. Ionides' suggestion that building is the basic industry of all industries. With respect, Sir, I should like to suggest that in these developing countries there is another industry which is just as basic and probably just as important—I refer to transport. It was really the development of transport that enabled civilization to spread from its nursery in the Middle East. Nowadays it is transport which is really the key to the development from a subsistence economy to a cash economy. It enables the local people to bring their produce out and enables the trader to bring his goods in. As an instance, in a district in Uganda just after the war they started building rudimentary roads, and this provided the incentive for the local people to increase the acreage planted with cotton by some sixfold.

On the other hand, it is surprising, and perhaps a little sad, that when travelling in West Africa, for instance, one often sees large motor cars parked at the side of huts which themselves do not provide much more accommodation than the cars. Here I think the people must within limits be allowed to choose the incentives they want. After all, what we are doing is helping to give the people a better chance to enjoy the benefits of civilization, and they must have freedom in what they choose. In general there can be no quarrel with Mr. Ionides' thesis, but I should like to add this proposition—that one of the best ways in which to encourage people to take a hand in their own development, is to provide them with a system of transport which they themselves can use.

THE LECTURER: I would not dispute your proposition, but I might add that before you can have roads you must have a building industry to build them. It is easy to over-generalize, and I am sure I have been guilty of it many times this afternoon, but I do think it possible to over-generalize on this question of transport. At the very early stages where there is a semi-nomadic community, the first problem is to get them to settle; so, the priority is something to make them settle—which is almost invariably water supplies. This comes before transport because you want people to build houses round a fixed place, and to encourage the cattle man to bring his meat and his milk there and sell it for cash and buy grain and vegetables and vice versa. But I would entirely agree that the moment there are some signs of the next stage of development into the cash economy, you want the roads—or at least, communications, which is not necessarily the same thing. There are countries which can go a long way with a dirt track before it is really worth while saddling government with the cost and the maintenance problems of proper roads.

MR. T. D. WEATHERHEAD (Hunting Surveys Ltd.): I realize that your plan has to be broad and general, but in the ekistic plan I got the impression that the whole emphasis was on rural development and the use of raw materials. Would you not agree, assuming

that Sigmaland is having to maintain an increasing population on a basically agricultural economy, that in order to get out of the subsistence economy stage you have got to introduce industry of some kind or other? I wonder whether in your emphasis on the ekistic plan you have not gone too much for small industry and local effort. One has got to take a wider view than that, I think. As you increase the efficiency of the agricultural areas obviously you diminish the amount of manpower there, and therefore you have to increase the population in the industrial areas.

My second point concerns the need for thorough and reliable information about emerging countries. It is often wrongly assumed that they themselves can provide the information about their basic resources, whether human, physical, economic or mineral. As capital investment is now so heavy the great danger is investing on the basis of out-of-date information.

THE LECTURER: Yes, I think you have put your finger on a very valid point. I probably have over-emphasized the local rural aspect. This is the penalty of trying to draw a contrasting picture. The right mixture must be a matter of adjustment and balance in the light of the facts, and this is where I come to your second point. The people of these countries usually do not know anything like as much as they are assumed to know: in terms of the measures of their resources, they often have not the knowledge necessary for the purposes of creating and guiding a development plan.

I have over-emphasized the extremes between things which are solely a matter of profitability, on the one hand, and things where the return is so indirect as to be uneconomic, on the other; but I hope I have not given any impression that I am against the economic propositions. I am simply against an over-emphasis on them to the exclusion of ekistic investment, because that leads to the kind of imbalance which ends in social unrest. If you take a complete development programme for a country, there are many items of which the ekistic man would say, 'I agree with you economists, you must do this because the country must earn the money, but on the other hand you should only do it if you can prove that it really is profitable'. But equally there are other things of which he might say, 'This you must do, even though you cannot prove that it is directly profitable'. This is why it is really necessary to have the two points of view.

MISS ALICE BOSTOCK: Mr. Ionides mentioned the Special Fund. I was particularly interested because I have been thinking that this was surely the way in which ekistic plans could work out; but he did not mention the Technical Assistance Fund (EPTA), and I wonder whether this also is not one way in which the ekistic plans are already working out. Is it not particularly interesting that Africa is now said to have suddenly discovered Technical Assistance, and therefore, since it has previously been developed in a colonial manner, we shall surely see these two plans at work and it may be that the two ways will come together—Technical Assistance which is being brought into Africa, a continent which has already been developed economically according to Plan A.

I have read recently that missionaries have been introducing technical assistance and skills in the same way that the United Nations does. I should like to know what funds are available for this: is it creating a development which will grow into something as big as the work of the specialized agencies?

THE LECTURER: I ought perhaps to have said something more about specialized agencies, but I have been talking this evening about capital investment, which is not quite the same thing, and of course the specialized agencies (F.A.O., World Health Organization and the others) do not have capital funds at their disposal. They provide technical experts; technical assistance in an advisory and not an executive capacity.

Now in order to pursue the lines of research and development which I have been outlining (those which lean towards ekistic development), money must be spent, and that is why I have emphasized the capital investment side. Taking the whole

array of agencies grouped round the United Nations I think there are only two, in this context, capable of providing capital sums—the International Bank and the International Development Association. The Special Fund is not for providing investment capital in the usual sense of the word, but for providing funds for gathering information and doing research and development.

The missionaries' 'community development' has been of immense value, but in my experience it suffers because it leaves too much to the individual initiative of technically untrained enthusiasts. It is not difficult to make a few villages enthusiastic about building roads, or a dispensary or the like. But these things have to be maintained. The Public Works and Public Health Departments are apt to say, 'We will have none of this because it is not done to our specification'. You are apt to find that things done in the heat of enthusiasm later disintegrate, and things done by enthusiastic amateurs which are technically unsatisfactory.

Now it would be part of the scheme I have been trying to express that there should be money put into working out the best practical way to do these practical jobs. For example, in a province of a country where conditions are more or less alike, there will be a team who, with the help of the community development people and the missionaries and others, would work out a practical manual of how to dig drains and how to make water tanks, how to do this and how to do that, which everyone could use. This is the sort of injection of technical aid that is wanted, and it is hardly yet being provided.

THE CHAIRMAN: When I listened to Mr. Ionides, I could not help thinking that some centuries ago England was a Sigmaland; it was almost entirely rural and agricultural in its outlook and economy. I assume you would say that it has developed into what it is mainly by ekistic methods, since we have never had any big brothers from over-the-seas ready to pour capital into it. I was wondering, too, whether the deplorable conditions that Edward Chadwick found one hundred years ago and brought to the knowledge of the public (and consequently got himself into such hot water that he was dismissed from office) were the result of the way in which this country itself had developed. But it is too late for me to ask you to discuss that, so I will come back to my main objective, which is to ask you to accord a very warm and cordial vote of thanks to Mr. Ionides for his most illuminating lecture.

The vote of thanks to the Lecturer was carried with acclamation and, another having been accorded to the Chairman upon the proposal of Sir Selwyn Selwyn-Clarke, the meeting then ended.

BAUXITE AND ALUMINIUM WITH PARTICULAR REFERENCE TO THE COMMONWEALTH

The Henry Morley Lecture by

WILFRED BRINING, F.C.A.,

Director, Imperial Aluminium Co. Ltd., delivered to the Commonwealth Section of the Society on Thursday, 25th May, 1961, with S. E. Clotworthy, C.B.E., Managing Director, Alcan Industries Ltd., in the Chair

THE CHAIRMAN: I think that Mr. Brining will do his subject, and this occasion of the Henry Morley Lecture, full justice. He has been in the aluminium industry for twenty-five years, and last year became President of the Aluminium Development Association. All of us in the industry are greatly indebted to him for his advice and counsel during what was then a very difficult period.

The following lecture, which was illustrated with lantern slides and a film, was then delivered.

THE LECTURE

Bauxite, which takes its name from Les Baux in France where it was first discovered in 1821, is not a specific mineral but is the term generally applied to residual soil or rock formed by weathering processes and which consists predominantly of hydrated aluminium oxide. It has been defined[1] as a material which contains 32 per cent or more of recoverable alumina by the Bayer process or combination Bayer process. Such materials include gibbsite, bôhmite and diaspore.

Bauxite is known mainly as the ore from which aluminium is produced. World production is rising rapidly—from 8½ million tons in 1950 to over 25 million tons in 1960. It is estimated that about 95 per cent of the bauxite produced is used in the production of alumina and that 90 per cent of this is consumed in the production of aluminium. The remaining 10 per cent is the source of aluminous chemicals, abrasives, refractories and insulators. Bauxite is also used directly in the manufacture of aluminous cement, oil filtration and in iron smelting. These are important and growing uses, but in this lecture I shall confine myself to the subject of bauxite as a source of aluminium.

Actually, the first aluminium was produced about the same time as the discovery of bauxite, for although the existence of the metal was first postulated by Sir Humphry Davy in 1808, the first particles of it were produced by Oarsted in 1825. Wohler carried this work further and produced a button of aluminium from which he determined some of the properties of the metal. These he published in 1854. In research sponsored by Napoleon III, Henri Ste. Claire Deville developed the first commercial reduction process about the same time and production commenced soon afterwards in France and England, but at £7 per pound

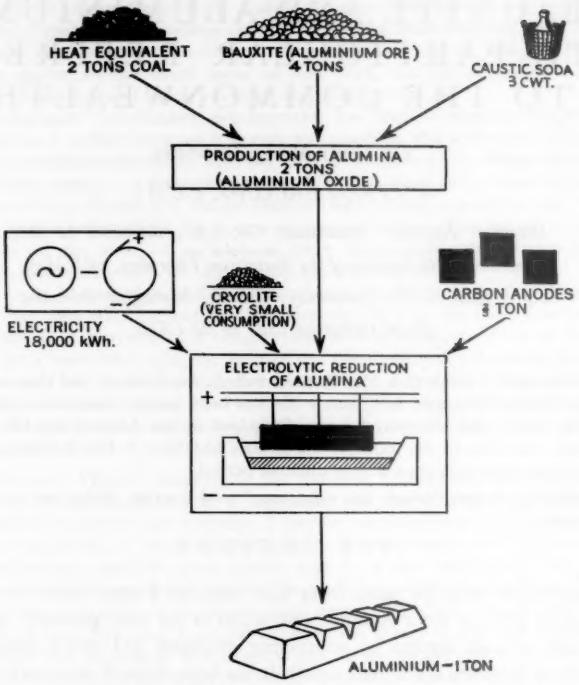


FIGURE 1. *The principal materials and sequence of operations in the Hall-Héroult process*

the applications of the metal were somewhat limited. In 1885 occurred what in modern jargon we should call the real break-through, in the almost simultaneous invention of the electrolytic reduction process by Paul Héroult in France and Charles Martin Hall in America. The first commercial operation of the Héroult invention was at Neuhausen, Switzerland in 1887 and the next year Hall founded in Pittsburgh the company which has since become the world's largest producer of aluminium.

It will, I think, be appropriate now to show diagramatically the principal materials used and the sequence of operations in the Hall-Héroult electrolytic process (Figure 1). It has been recently announced in Canada and in France that substantial progress has been made with new thermal reduction processes for virgin aluminium production, of which, I believe, much may be heard in the next few years.

THE BAYER PROCESS

Most of the alumina used in the production of aluminium to-day is made by the Bayer process. In this process ground bauxite is digested in hot caustic soda

to produce a sodium aluminate solution which is then discharged and diluted and the insoluble residue ('red mud') is separated by filtration, sedimentation or both. The clear solution is cooled and stirred with a seed charge of hydrated alumina to precipitate the soluble sodium aluminate as a hydrated aluminium oxide. After washing to remove soda, the precipitate is calcined to produce anhydrous alumina.

There are variations in plant and process details between various alumina producers attributable mainly to the different compositions of bauxite used, but in general for the manufacture of aluminium and aluminous chemicals the bauxite should preferably not contain more than 5 per cent silica, since the alumina and soda recoveries vary inversely with the silica content of the bauxite. Beneficiation processes have been devised for rendering bauxite of higher silica contents suitable for the Bayer process. Iron oxide content is not important for metal production, but for the production of chemicals and refractories it should be as low as possible.

OTHER PROCESSES

Aluminium is the most abundant metal in the earth's crust and its wide distribution in aluminous materials other than high grade bauxite has encouraged a great many attempts to develop alternative methods, but so far no method has been devised for producing alumina for aluminium production which can compete economically with the Bayer process, although there are some instances of successful operation of such processes in special circumstances. Chief among these are the Pedersen process, which has been operated in Norway for more than 25 years (this process yields foundry iron as a by-product), and the Alcoa combination process used for the treatment of high-silica Arkansas bauxite.

Another interesting development is the process which I understand is now in operation in Russia for extracting alumina from nepheline,[2] of which they have very large quantities available. The economics of this process depend, however, on the utilization in the manufacture of Portland cement of the large volumes of nepheline waste which it yields.

The development of alternative processes is still being actively pursued, for the reason that while there appear ample total supplies of low silica bauxite available, they are in comparatively few hands and often far from the main industrial centres. Since clays and shales of high alumina content are far more widespread, the means for their exploitation are sought for commercial reasons as well as for reasons of national self-sufficiency.

An American producer has recently released some details of its research work on the extraction of alumina from clay. It plans to test several processes on a pilot plant scale. I was particularly interested to note that they have under consideration the treatment of alumina-bearing shales at the coal mines, since I recall that during the war we investigated the alumina content of various pit-head slag heaps in the U.K. and found them to contain proportions of alumina which such a process might make economical to work.

BAUXITE AND ALUMINIUM IN THE COMMONWEALTH

The Commonwealth has a special interest in aluminium and its source bauxite.

TABLE I

PRODUCTION OF BAUXITE IN THE COMMONWEALTH

(*thousands of tons*)

	1938	1950	1955	1959
Australia	1·8	3·5	7·7	15·2
British Guiana[1]	382·4	1,668·4	2,474·4	1,615·0
Ghana[2]	—	116·8	118·2	150·2
India	15·0	65·4	82·5	126·5
Jamaica	—	—	2,687·8	5,264·2
Malaya	56·0	—	225·8	387·9
Pakistan	—	—	1·0	2·2
Sarawak	—	—	—	188·0
Total Commonwealth ...	455·2	1,854·1	5,597·4	7,899·4
Total World Production...	3,929·9	8,445·9	17,760·4	22,500·2
Commonwealth % ...	11½%	22%	31½%	39%

[1]Dried equivalent [2]Exports

Sources: *The Mineral Industry of the British Empire and Foreign Countries*, H.M.S.O., 1948; 'Metal Statistics 1950–1959', *Metallgesellschaft*.

TABLE II

IMPORTS OF BAUXITE AND ALUMINA—1958 BY PRINCIPAL IMPORTING COUNTRIES

(*thousands of long tons*)

	Bauxite	*Alumina*
U.K.	351	—
Canada	1,934[1]	135[2]
Australia	69	—
Austria	6	99
France	39	—
Germany	1,055	—
Italy	181	—
Netherlands	8	5
Norway	36	194
Spain	18	41
Sweden	3	19
Switzerland	60	—
U.S.A.	7,949	48
Mexico	4	4
Argentine	27	—
Japan	509	—
Formosa	41	—
U.S.S.R. (from Greece)	443	—

[1]Bauxite and alumina for aluminium production
[2]Bauxite and alumina for other purposes

Source: *Statistical Summary of the Mineral Industry*, H.M.S.O., 1960.

Countries of the Commonwealth contain over 40 per cent of the known bauxite deposits and supply about 35 per cent of the requirements of the world aluminium industry (Tables I and II). The Commonwealth accounted in 1959 for nearly 15 per cent of the production of aluminium and about 10 per cent of its fabrication and use, and the great new schemes now in hand will substantially increase these in the next five or six years. Thus, the Commonwealth is able to, and I am pleased to note, does supply most of its own requirements of bauxite and aluminium from its own resources, leaving a substantial margin for export to the rest of the world. The gross value of bauxite, alumina and aluminium produced is probably in excess of £200,000,000 a year and could be doubled when all the new plans come to fruition.

Since the commercial production of aluminium first began 73 years ago, its consumption has doubled about every 10 years. Up to 1939 its price—which was rather high in relation to those of other engineering materials—and lack of experience of its use, tended to restrict it to applications where its light weight and high thermal and electrical conductivity could be exploited most directly. In fact, the principal uses were in aircraft, motor cars and power cables, the general public encountering it mainly in the form of saucepans and the so-called 'silver paper'. In 1939 Germany was the world's largest aluminium producer, with an output of 192,000 tons—not very far short of those of U.S.A. and Canada combined. In the Commonwealth only British Guiana was a major bauxite producer and Canada and the U.K. its only aluminium producers, supplying 11 per cent of world bauxite and 14 per cent of world aluminium. I think that here we might take a look at the growth in aluminium producing capacity since 1938 and its projected growth in the next five years (Table III).

It is in the past 15 years that the greatest strides have been made in developing widespread markets for aluminium, changing it from a 'new' material for advanced engineering applications to an ordinary material of every-day use. This period has seen supply and demand alternately outstripping one another, though supply is now more than adequate and is likely to remain so in the immediate future.

The rapid growth of aluminium production and its emergence since the war as a major industrial material, coupled with political and economic developments in the Commonwealth, have so stimulated interest that new discoveries of bauxite and new aluminium-producing schemes are being announced and amended with bewildering frequency. Indeed, in the short period between the preparation and presentation of this paper, it has been announced that a 50,000 ton smelter is to be established in Kuwait using natural gas for power production and operating from alumina imported probably from West Africa. It is therefore difficult to focus a clear picture of the situation at a given moment. In these circumstances it is tempting to give an account of the position as it was, say, two years ago, which is the latest date for which complete statistics are available, but this would have omitted many of the most interesting developments and plans and I have decided, therefore, to risk a more up-to-date account of the situation and even to indulge in a little crystal-gazing. To do this it is necessary to rely sometimes on unchecked and often rather garbled reports from far-off places.

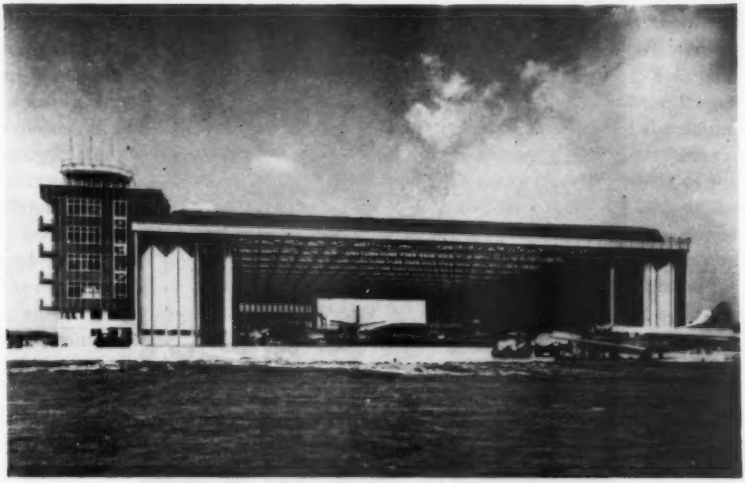
TABLE III

ALUMINIUM PRODUCING CAPACITY IN 1960 AND PROJECTED CAPACITY BY 1965 COMPARED TO PRODUCTION IN 1938

(*thousands of tons*)

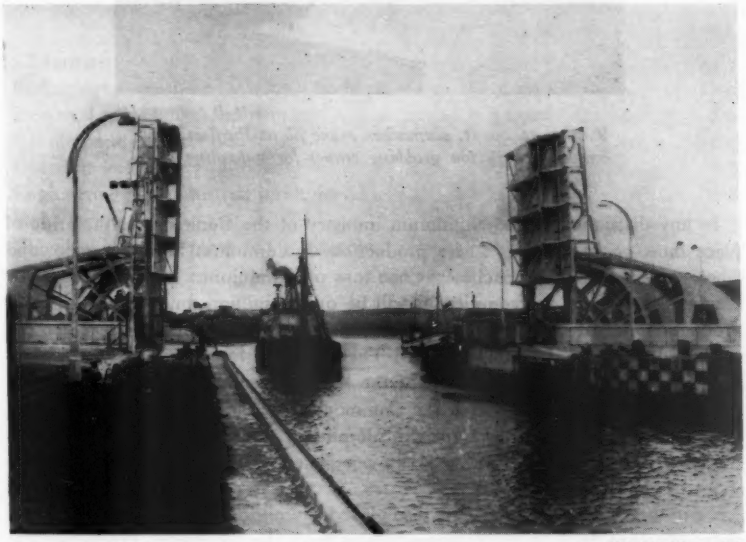
	1938	1960	1965
Commonwealth			
Australia	—	13	28
Canada	65	785	1,100
India	—	17	107
New Zealand	—	—	120
Ghana	—	—	120
U.K.	23	33	33
Total Commonwealth	88	848	1,508
Americas			
U.S.A.	130	2,172	2,370
Brazil	—	20	50
Western Europe			
France	45	265	400
Western Germany	161[1]	180	246
Italy	26	84	180
Norway	29	180	300
Sweden	2	15	15
Austria	4	73	73
Switzerland	26	35	58
Yugoslavia	1	23	38
Spain	1	23	44
Greece	—	—	52
Africa			
Cameroons	—	45	70
Asia			
Japan	18	140	430
Formosa	5	10	20
Eastern Bloc[2]	53	850	2,250
World Total	589	4,963	8,104

[1]All Germany [2]Estimated



[S. M. D. Engineers, Ltd.

FIGURE 2. *Flight hanger for the 'Comet' jet airliner at Hatfield; a clear span of 200 ft.*



[Head Wrightson, Ltd.

FIGURE 3. *St. Clement's bridge, Aberdeen*

[*S. M. D. Engineers, Ltd.*

FIGURE 4. *90 ft. aluminium crane jib at Purfleet jetty; one of five 7½ ton grabbing cranes for unloading ships*

In any discussion of the aluminium industry of the Commonwealth, pride of place must go to Canada, where production of aluminium began in 1900, and where capacity now approaches 785,000 tons of aluminium a year; when all the planned expansions are complete it will be over 1 million tons—equal to world production in 1941. (Fellows will recall the paper on the Kitimat Development presented by F. L. Lawton in 1953.) The Canadian interests have also played a leading part in the development of the bauxite resources and the aluminium fabricating industries throughout the Commonwealth.

About 85 per cent of the Canadian aluminium output is exported. In 1960, Commonwealth countries took over 45 per cent of its exports and the U.S.A. about 18 per cent.

We in the United Kingdom have also played an important rôle in the aluminium story. We have been in the business almost from the beginning. Production by the Deville process began in 1859, although serious commercial production by the

Hall-Héroult process did not start until 1896. We do not have the bauxite or hydro-electric power to be an important factor on the production side (and so important is the latter that aluminium has been called 'packaged power'), but we have built up an aluminium fabricating industry exceeded only by those of the U.S.A. and probably Russia, and are the largest importers of primary metal and the largest exporters of fabricated aluminium. U.K. exports of semi-manufactured aluminium in 1960 were valued at about £17¼ million, of which over £10 million went to countries of the Commonwealth. These figures do not include the value of the aluminium content of manufactured goods.

I would claim, also, that members of the U.K. aluminium industry, severally and through the Aluminium Development Association, have pioneered many of the important new uses of aluminium which have been developed since the war.

In the immediate post-war years the U.K. led the way in the large-scale use of aluminium in building and structural engineering, starting with the prefabricated houses, followed by the Dome of Discovery, the aircraft hangars at London Airport, Hatfield (Figure 2) and Thirleigh, bridges at Sunderland and Aberdeen (Figure 3), cranes (Figure 4) and other outstanding structures. More recently, we have the new trains on the London Underground and the all-welded aluminium super-structures of the liners *Oriana* and *Canberra*. Table IV shows the principal fields of use of aluminium in the U.K. in 1960.

TABLE IV

PRINCIPAL U.K. ALUMINIUM END-USES IN 1960

	Tons	%
All forms of transport	109,600 ...	29·7
Packaging[1]	40,700 ...	11·0
Electrical plant and equipment	32,700 ...	8·9
Building and construction	30,800 ...	8·4
Domestic and office equipment	28,000 ...	7·6
Engineering and industrial machinery ...	25,100 ...	6·8
Holloware	8,400 ...	2·3
Chemical and food plant and equipment ...	5,400 ...	1·5
Other uses	47,900 ...	13·0
	328,600	89·2
Direct exports	40,000	10·8
	368,600	100·0

[1] Certain of the material covered by this heading is employed eventually in the insulation sphere.

Having noted the achievements of the U.K. and Canada, I must now proceed to relate the positions occupied in the bauxite and aluminium fields by the other Commonwealth countries.

India

In 1959 primary aluminium production in India was 17,000 tons and consumption 23,000 tons, most of the balance being imported from Canada. Most forms of fabrication are carried out in modern plants. Bauxite occurs in several locations in India, the principal deposits being in the Deccan Plateau in Central India, in the Ranchi district of Bihar, in the region of Jubbulpore and Balaghat in the Madhya Pradesh near Jammu and Riasi in Kashmir, and near Bidi in Saurashtra. The Saurashtra deposits contain what is probably the highest purity bauxite in the world, containing over 64 per cent alumina and iron oxide and silica contents each below 1 per cent. It has recently been announced[3] that there may be 6 million tons or more of this high grade bauxite in a deposit in the Jamnagar region of Saurashtra located almost at sea level under about 20 ft. of overburden. There is mention of a local aluminium reduction plant to exploit these deposits, possibly with Japanese assistance.

Bauxite reserves in India are estimated at 270 million tons, of which about a quarter is proven high-grade ore suitable for metal production. Mining has steadily increased from 65,000 tons in 1950 to 215,000 tons in 1959, 23,000 tons of which were exported and the remainder used in the production of aluminous chemicals, etc., and in the growing Indian aluminium production.

With its large bauxite deposits, power potential and rapidly growing industrialization, India is bound to become an increasingly important factor in the aluminium industry, and considerable expansions are already planned. The capacity of the smelter at Hirakud, which is largely owned by Canadian interests, will be doubled to 20,000 tons by the end of the year[4] and the other existing plant is increasing its capacity to 7,500 tons.

A 20,000-ton smelter is being built, in co-operation with U.S.A. interests, in Uttar Pradesh State, which is expected to commence production next year using imported alumina initially.[5] A 60,000-ton smelter is projected for Mysore State. The cost will be about £27 million and it is hoped to commence production in 1963.[6] However, it has already been stated that India's aluminium requirements will reach 150,000 tons a year by 1965–66.[7] With present *per capita* consumption in this vast country averaging only 0·2 lb., even the planned increase to about 0·5 lb leaves a potential market of vast proportions to be developed, bearing in mind that *per capita* consumption in Western Europe is 6½ lb. and that of the U.S.A. over 22 lb.

British Guiana

Bauxite has been mined in British Guiana since 1917, and the country has been a major producer since 1920. Bauxite is its second largest industry after sugar, and in 1957 provided about 20 per cent of the total Government income in a country of half a million people.

Ore from the Damerara deposits is railed to a beneficiation and drying plant at Mackenzie and shipped thence in shallow draught ocean-going vessels; the chemical refractory and abrasive grades direct to North America and other world markets, and substantial quantities of metal grade to the Island of Trinidad for trans-shipment into larger and more economic ore carriers for transport to Canada.

Bauxite from Kwakwani on the Berbice River is treated and dried at Everton and carried thence in small ocean-going ships to U.S.A.

Reserves of metal grade bauxite in British Guiana are conservatively estimated at 80 million tons. Up to 1951 about 17½ million tons had been mined, and since then the average annual rate has been about 2½ million tons. British Guiana is the world's leading producer of calcined bauxite for refractories, etc., and has the largest calcining plant with a capacity of over 300,000 tons a year. The latest stage in the development of the country's bauxite industry is the opening earlier this year of the new alumina plant at Mackenzie with a capacity of 230,000 tons a year. This represents an investment of some £13½ million, of which £5½ million was spent in British Guiana.

Jamaica

The mining of bauxite in Jamaica is a new development associated with the rapid growth of aluminium production capacity in North America in the 1950s. Output has risen at an unprecedented rate from 346,000 tons in 1952 to nearly 6 million tons in 1958, making Jamaica the largest producer of bauxite in the world. The deposits are excellent for opencast mining, being in the form of finely divided earthy material with an average thickness of about 20 ft. with an overburden rarely more than 2 ft. Reserves are estimated at between 350 and 400 million tons.

In 1960 exports were:

Bauxite	4,856,924 tons
Alumina	665,361 tons

About a third of the bauxite mined is converted to alumina in Jamaica, the remainder being exported after drying. Investment by the three bauxite companies (only one of which produces alumina on the island) up to 1959 was over £40,000,000, and they employ over 6,000 people. In 1957–58 tax and royalties on bauxite operations accounted for 10 per cent of Government revenue, and in 1958 it was anticipated that revenue from the industry might reach $25 million by 1960–61, or a quarter or even a third of the country's total revenue.[8]

The other major bauxite-exporting members of the Commonwealth are Malaya and Sarawak, both industries being of recent origin. The main bauxite deposits in Malaya are at Pengarraw on the south-east coast of Johore. Production has increased rapidly from 22,000 tons in 1952 to 452,000 tons in 1960. In Sarawak the bauxite deposits near the mouth of the Sematan River have been mined since 1957, production reaching 285,000 tons in 1960. The rapidly growing Japanese aluminium industry is the principal customer for the bauxite exports of both countries.

Important deposits of bauxite have been found in Sierra Leone and Nyasaland. It has recently been reported[9] that mining of the Sierra Leone deposits is likely to commence next year by Swiss aluminium interests. It is proposed to erect an alumina plant to process the bauxite at the mines. The Nyasaland bauxite deposits estimated at 40 million tons are on Mount Mlanje near Blantyre. The rather unfavourable location of these deposits has so far prevented their exploitation, but

the possibility of hydro-electric power development on the Shire River may alter this in the future.

I have left to last the two most exciting Commonwealth aluminium projects. The Volta River scheme in Ghana and the plan to produce aluminium in South Island, New Zealand, from the vast bauxite deposits in Queensland, Australia.

Ghana has large deposits of metal grade bauxite estimated at some 250 million tons, and those at Awaso have been worked by a British company since 1942 at the rate of about 150,000 tons a year. The largest deposit is near Yenahin, and this was intended to be the main source of ore for the proposed Volta River scheme which, in its original form, appeared to offer the most completely integrated project for the production of aluminium so far proposed.

The Volta scheme has been the subject of a great deal of discussion and has undergone many changes since it was first proposed before the war. It was examined in a White Paper in 1952 and a very comprehensive report on it was published in 1955 by the Preparatory Commission appointed in 1953. The original White Paper scheme envisaged a partnership between the Ghana and U.K. Governments, and Canadian and U.K. aluminium companies. The companies have since withdrawn, however, and have been replaced by a consortium of leading U.S.A. producers.

The original scheme consisted of the development of bauxite mines, building 83 miles of railways, construction of a large dam to form a 3,500 square mile reservoir, a power station of some 600,000kW, an alumina factory and a smelter with an ultimate capacity of 210,000 tons, new roads, a new port and new townships. The total cost of the full scheme was estimated by the Commission as about £230 million, but since then a revised scheme reducing this to about £180 million has been proposed. It has recently been announced that work on the power project may start by the end of this year and that power should start flowing in September, 1965.[10]

There is no doubt that when this scheme is fully implemented it will have a decisive impact on the economy of Ghana, adding over £20 million rising to £40 million a year to the national product, quite apart from the benefits available to others from the surplus power created. Assuming that most of the aluminium produced would be exported, this would initially represent an increase of 20 per cent over 1959 total exports, and would be second only to cocoa in importance. My latest information is that it is intended, initially, to produce aluminium from imported alumina; so the full achievement to these figures must await the later development of bauxite mining and the construction of the alumina plant.

Australia

Until recently bauxite has been mined on a relatively small scale in New South Wales, Queensland and Victoria but not in sufficient quantity for the requirements of the Bell Bay smelter in Tasmania, which started operations in 1955. The planned capacity was 13,000 tons of aluminium by 1960. Bauxite for the alumina plant at Bell Bay up to mid-1959 had come mainly from the Indonesian island of Bintan and, it was reported, may be drawn also from Malaya, India or Borneo. It now appears likely that bauxite or alumina may be drawn entirely from Queensland

when that scheme has come to fruition. The stop-press news is of the discovery in Western Australia of a bauxite deposit estimated at 30,000,000 tons. A trial quantity has already been shipped to Japan. The vast bauxite deposits discovered during the past five years in the Cape York Peninsula, Queensland, have aroused world-wide interest, since the estimated reserve is over 1,000 million tons.[11]

The area covered by the deposits on the Gulf of Carpentaria measures some 150 miles by up to 130 miles. It is proposed[12] to build a 360,000 ton alumina plant at Weipa with associated harbour and civil works, and to construct a 280,000 kilowatt hydro-electric station and a 120,000 ton aluminium reduction plant at Bluff near Invercargill, South Island, New Zealand. A 40,000-ton plant in Queensland is also contemplated. The power station is to be constructed to allow for a doubling of capacity later. The company will also have a two-thirds interest in the new company which will run the Bell Bay smelter in Tasmania—the other third being retained by the Tasmanian Government. This plant will also be supplied partly with alumina from Weipa. Capacity at Bell Bay is to be increased from 13,000 tons to 28,000 tons and further expansion is contemplated later. The target date for completion of the whole scheme is 1966.

RAW MATERIALS

Although in former years concern was sometimes expressed about the extent of reserves of bauxite, the intensive prospecting which has taken place since 1945 has led to the discovery of many vast deposits, and the latest estimates[13] put the known reserves of metal quality bauxite at 7,500 million tons, and further discoveries are bound to be made. Moreover, as I have already mentioned, bauxite is by no means the only possible source of aluminium. Processes have been and are being developed for extracting metal from the more widely distributed aluminous minerals.

In short, it appears that there is not and will not be in the foreseeable future a shortage of aluminium ore, so that the discovery of new deposits is not of itself a guarantee that they will command a ready sale. Why then is so much interest aroused in recent discoveries of bauxite deposits such as those in Cape York? The answer lies in the complex balance of financial, economic and political factors such as location of raw material, ownership of mining rights, new techniques, costs of freight, power, other materials, availability of markets, financial atmosphere, taxation, political stability and so on.

One factor which does emerge clearly, however, is the trend towards reducing handling and freight costs. This favours the development of bauxite deposits located near the coast so that within a reasonably short-haul, alumina plants may be erected beside wharfage for large ocean-going alumina carriers. Similarly, the factors governing the location of new reduction plants are availability of low cost hydro-electric potential within reasonable transmission distance of navigable waters, so that the alumina may be discharged direct from the ships into the plant and the metal produced despatched to not too distant markets. Integration is taken a step farther when all three elements—bauxite, power and harbourage—can be brought close enough together to operate as a unit. This is the attraction of the original Volta River Scheme.

TABLE V

PRODUCTION AND CONSUMPTION OF PRIMARY ALUMINIUM IN 1959

Commonwealth	*Production thousands of metric tons*		*Consumption thousands of metric tons*	
Australia and New Zealand	13		30	
Canada	544		80	
India	17		23	
U.K.	25		294	
Union of South Africa	—		8	
		599		435
Europe				
Germany	151		228	
France	173		168	
Italy	75		83	
Norway	145		16	
Austria	66		29	
Switzerland	34		42	
Spain	21		37	
Sweden	15		30	
Other	19		106	
		699		739
America				
U.S.A.	1,772		1,846	
Brazil	15		25	
Other	—		29	
		1,787		1,900
Asia				
Japan	100		111	
China	70		80	
Other	7		12	
		177		203
Africa				
Cameroons	42		—	
Other	—		2	
		42		2
U.S.S.R.	630		520	
E. Germany	35		60	
Poland	23		26	
Rumania	10		—	
Czechoslovakia	40		40	
Hungary	46		44	
Other	—		20	
		784		710
World Total		4,088		3,989

Source: 'Metal statistics 1950–1959', *Metallgesellschaft*.

Technically such schemes have great attraction and seem to offer the best prospects for the further growth of the aluminium industry in economic competition with alternative materials. Political considerations must be taken into account, however. The worth while schemes, by their very size, require very large capital investment, much of which must be found outside, and the return yielded by aluminium production at the present time at any rate is not such as to encourage the taking of political as well as ordinary commercial risks. Furthermore, because of the location of bauxite deposits these large schemes must depend for many years to come on overseas markets for their aluminium output, and here they seem likely increasingly to face the growing urge of all countries to self-sufficiency in aluminium—a tendency which the development of new techniques for treating more widely distributed aluminous materials is bound to increase.

Table V shows that in general the major industrial countries are net importers of aluminium or are self-sufficient. The major exporting countries are Canada, Norway, France, Austria, the U.S.S.R., and the French Cameroons. Since 1959 the U.S.A. has become a major exporter, exporting 254,000 tons of virgin aluminium in 1960.

In both Canada and Norway aluminium production has been undertaken to take advantage of the availability of plentiful hydro-electric power for the reduction process. The eastern plants in Canada manufacture their alumina requirements largely from bauxite imported from British Guiana and Surinam, but the new tendency is to process the bauxite at source, thereby halving the freight costs and improving local economy by increasing the value of the exports from about £2 10*s* to £30 a ton. The new west coast Canadian smelter at Kitimat is supplied with alumina produced in Jamaica. Norway also works mainly from imported alumina, but the position is perhaps sufficiently illustrated by Table II.

According to official trade accounts, in 1960 the value per ton f.o.b. exporting countries averaged £2–£3 for crude and dried bauxite and £7–£8 for calcined bauxite.

FREIGHT

Freight charges and thus location play a vital part in the cost of aluminium production. A. L. Ellis[14] has listed the sources of supply of the Bell Bay smelter:

Material	*Source*
Bauxite	Bintan Island
Soda ash	South Australia
Limestone	Local
Pitch (7,000 tons p.a.)	U.K.
Petroleum oil coke	U.S.A.
Anthracite	U.K.
Cryolite	Greenland and Germany

POWER COSTS

Electric power is the one component which cannot be transported cheaply over very long distances, and hence the tendency has been to locate the reduction plants

where low cost power is available—generally this has meant water-power—with reasonable accessibility to markets for the metal.

The cost of power is one of the principal charges on the conventional electrolytic reduction process despite the considerable advances made in reducing specific consumption in recent years, which is of the order of 18,000 kWh per ton of aluminium produced. Recently published figures[15] indicate that in the U.S.A. power costs ranging from 0·17 to 0·31 pence per kWh account for 6½ per cent to 12·7 per cent of the selling price of the metal, i.e., £13½ to £27 a ton. A. L. Ellis[16] puts the figure rather higher.

At present the lowest cost producers in Canada, Norway and the U.S.A. pay about 0·17 pence per kWh[17] and this figure seems to be the target for new aluminium projects. This is about the estimated cost for the proposed installation at Bluff in New Zealand[18] and for the Volta River scheme.[19]

CAPITAL COSTS

The new aluminium facilities being built and projected involve the expenditure of huge capital sums. The cost of a particular project varies, of course, according to its scope and location, but in order to give a rough idea of what a new aluminium project may cost, I have listed some recently published figures for a number of projects:

Location	*Capacity tons p.a.*	*Capital £ millions*	*Year*	*Approximate Capital Cost per ton-year of aluminium capacity (2 tons alumina = 1 ton aluminium)*
Alumina Plants				£
British Guiana...	230,000	13½	1961	120
Jamaica ...	730,000	35½	1957	100
West Africa ...	230,000	11½	1959	100
Aluminium Smelter				
West Africa ...	120,000	24	1959	200
Combined Hydro-Electric, Alumina and Aluminium Installations				
Volta River ...	180,000	123½	1960	686
Australia/ New Zealand ...	120,000	100	1961	833

It would appear, therefore, that the cost of a complete scheme from bauxite to aluminium is about £700 to £800 per ton of aluminium producing capacity. This may not be the whole cost, however. The report of the Preparatory Commission on the Volta Project estimated that in addition to the capital cost of the dam, power installation, smelter and mines amounting to £757 per ton, the cost to the Ghana Government of the necessary railways, docks, etc., would add

another £340 per ton, making over £1,100 per ton in all. Of course, not all of this sum is chargeable to aluminium production, but it does indicate the scale of investment which may be necessary before production can begin.

OPERATING COSTS

Detailed costs for aluminium production are not easily come by. The most recent figures I have been able to find were published in 1957 and are as follows:

Estimated Cost of Producing Aluminium in a U.S.A. Plant of 62,000 ton capacity[20] *using power at cost comparable to that from T.V.A.*

	Cents per lb.
Electricity	3·83
Alumina	7·07
Cryolite and AlF_3	0·75
Labour (including overheads)	2·40
Repairs and maintenance	1·00
Electrodes (Anode Paste)	1·50
Miscellaneous plant costs and indirect overheads	1·45
Total operating costs	18·00
Freight to customers	1·00
Amortization, interest and profit	6·00
Delivered price of aluminium pig	25·00

It will be noted that the cost of electricity given for this plant is a good deal higher than those of the projects to which I have referred.

FUTURE DEMAND

Nathanael V. Davis, a leading figure in the world aluminium industry, has recently[21] given a thoughtful assessment of the outlook for aluminium in the next few years. He estimates that demand in the non-communist world will continue its recent rate of growth of 2–4 per cent per annum, reaching 5 million tons by 1965 (which is more or less in line with the Paley report). Presently planned production capacity should then at least equal that demand but, he warned, capacity could easily exceed 7 million tons if other contemplated expansion projects are embarked on too quickly and with too little regard for reality. This would perpetuate the present over-capacity in the industry.

In contrast to this sober point of view, we have the more optimistic viewpoint expressed by certain American organizations that the consumption of aluminium has increased by 10 per cent per annum over the past 10 years and that there is no reason to doubt that it will continue to expand at the same rate for the next 10 years. This view is reinforced by the great differences between *per capita* consumption in the U.S.A., at present 22·3 lb.—compared to the next highest—Western Europe, now 6·5 lb.

TABLE VI

CONSUMPTION OF ALUMINIUM IN THE COMMONWEALTH

Country	*Population (millions)*	*Aluminium Consumption Thousands of tons*	*lb per capita*
Australia[1]	10 ...	37	8·3
Canada[2]	17 ...	67 ...	8·8
India[1]	403 ...	36 ...	0·21
United Kingdom[3]	52 ...	329 ...	14·2
Others[4]	212 ...	25 ...	0·26
Total	694	494	1·57

[1]Production plus imports of ingot and semis.
[2]Production less exports of ingot and semis.
[3]Fabricated output less exports.
[4]Imports.

Undoubtedly the Commonwealth offers a vast potential market for aluminium. Table VI shows that at present its 700 million people use half a million tons a year of aluminium between them—about 1·57 lb. *per capita*, and if we exclude U.K. consumption, the figure becomes less than ½ lb. Consumption of aluminium foil alone in U.K. is at the rate of 1 lb. *per capita*, not counting the considerable volume of foil wrappings of imported commodities. An increase of Commonwealth consumption to the still modest average of 3 lb. a head during the next ten years would raise the consumption of aluminium in the Commonwealth to almost a million tons a year and, looking farther ahead, an overall increase to the present West European rate of *per capita* consumption would double Commonwealth demand again—more than the consumption of the whole world less than ten years ago (1,957,300 tons in 1952).

It must not be overlooked, however, that the production of aluminium metal is but the half-way state towards its use. It still has to be fabricated into castings, sheet, sections, tubes, foil, etc. Most fabricating operations are and, I believe, will continue to be carried out close to the aluminium-using industries, for at this stage close technical co-operation between fabricator and user are often necessary and many aluminium products, being in their nearly finished form, are costly to protect against damage and to transport. One of the most interesting recent developments has been the so-called 'hot metal' deals in America whereby, in order to save the cost of remelting the metal, it is supplied in the molten state direct from the reduction plant to the foundry for casting into motor car engine components. In some cases the motor manufacturer has built a foundry alongside the reduction plant but in others the molten metal is being hauled quite considerable distances. Just how far this idea can be developed I cannot say, but it does pose further questions regarding the location of plants to produce both primary and secondary aluminium.

On the other hand, new aluminium fabricating facilities are being established in many of the less industrialized countries, usually with the backing of major

North American producers. A £1 million rolling mill is to be established in Ghana by the company which has been producing building sheet there since 1959. A rolling mill is being built in Malaya at a cost of about £½ million. Initial capacity will be 2,000 tons a year from ingot supplied from Canada.[22] Several similar projects are in hand in other countries.

CONCLUSION

If I recapitulate the salient requirements for aluminium production, they are:

1. Bauxite of good quality and ready availability, and
2. The cheapest possible power.
3. Ample capital reserves.

It has been seen in this lecture that bauxite deposits are world wide; it is known that hydro-electric stations provide the cheapest power. Capital costs of establishing production units have been shown as ranging from £600 to £700 per ton, figures which mean that financing cannot necessarily be undertaken by the country in which a unit is built. It must therefore follow that aluminium production is truly an international operation, since no one nation has a self-sufficiency of both requirements. Capital, consequently, is found to be globally invested by concerns having headquarters in different countries and pride can be taken in the fact that Canada is in the van of the universal expansionist programme.

The expansion programmes which I have mentioned will naturally raise the question of 'Where will the consumers come from?' The brief answer is—the consumers are here now. Taking the Commonwealth as a whole, the consumption of aluminium *per capita* is 1·57 lb. per annum. In the U.K. the figure is 14 lb. and in the U.S.A. 22 lb. The advancement of standards of living resulting in a Commonwealth usage on U.K. levels will call for 4 million extra tons of aluminium, whilst to reach U.S.A. standards an extra of 6 million tons p.a. will be needed; a most encouraging picture.

Economically and strategically, aluminium production from bauxite to its finished form of sheet, extrusion, casting or forging has played an important part in Commonwealth progress and will continue so to do.

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DISCUSSION

MR. A. POWIS BALE, M.I.MECH.E.: Little mention was made of alloy in Mr. Brining's lecture. The term aluminium was used when obviously it was aluminium alloy which was being discussed. One other point, the most interesting to me, was the project of using the heat economically by taking the molten alloy direct to the foundry. Could we have a little more information on by-products or heat utilization?

THE LECTURER: On the matter of terminology—whether one should say 'aluminium' or 'aluminium alloy', the present tendency is to use the word 'aluminium' to describe all forms of the metal, and to use the terms 'pure aluminium' and 'aluminium alloy' when it is clearly necessary to do so in the context.

As to the utilization of heat, I am not quite sure of the gist of your question. But one development is the use of a specially designed truck with a specially insulated ladle carrying the metal direct from the smelters to the foundry concerned. A case was announced within the last week or two where a North-American producer is going to carry metal for 285 miles, so that their insulating problems must have been circumvented by now.

MR. A CROSBY, M.SC.: The speaker mentioned new processes. Will he tell us more about them and their advantages?

THE LECTURER: I presume the question refers to the new processes which have been announced in Canada. An announcement was made about July of last year, by the principal Canadian producer, that after many years of experiment an entirely new process for the production of aluminium had been evolved. They could not tell us what it was, but it was an entirely new process. It seems to be of great importance because although it does not use much less power than the conventional process, it offers very great advantages in the reduction of other operating costs and certainly in capital cost. More than that I cannot tell you.

As regards the French process, an examination of the patent suggests a three-stage process, again an electro-thermal one, which concludes with an operation requiring very high temperatures, something of the order of 1650 to 1900 degrees centigrade under vacuum. Again, nothing is published. But in both processes it is emphasized that bauxite is used as the raw material.

GENERAL SIR GEOFFREY BOURNE, G.C.B., K.B.E., C.M.G. (Director-General, Aluminium Development Assn.): The lecturer quoted two opinions about the rate of expansion in the industry—one, rather modest and careful, from Mr. Nathanael Davis, and the other a more optimistic estimate based on the American expectation of an increase of 10 per cent per annum. With relation to the Commonwealth, would the speaker care to say which target he thinks is the right one for us to aim at?

THE LECTURER: I am going to be optimistic and side with the Americans, because I believe in the expansion of the standards of civilization. We have to raise our standards so little in so many parts of the Commonwealth that the impact on aluminium production can be simply dynamic.

MR. S. G. SOMAN: In view of the optimism which has been shown about Jamaican production and your added information about the United States power contribution towards the cost—which I believe you said was around 12 per cent—could you give us information as to the cost of power in Jamaica and its relation to production?

THE LECTURER: I am afraid there are no published costs. Jamaican plant is not a smelter. The production in Jamaica is of two things, bauxite and alumina. There is no large electric power station in Jamaica.

MR. SOMAN: I understand merely from press reports that it is hoped to produce

aluminium in Jamaica. This is very pertinent to the problem of the expansion of employment in the Island.

THE LECTURER: I agree with you that if a smelter were established in Jamaica then certainly power costs would be very important, but frankly I have no information of intentions to establish a smelter in Jamaica. There may be some of our overseas friends here tonight who have more up-to-date information.

MR. A. L. PENDREY, B.SC.: In view of the last question, is it not possible that the geographical distribution of aluminium extraction will be completely modified as transport costs rise and atomic energy becomes more readily available at the bauxite deposits, which could well come about in twenty years or so?

THE LECTURER: That is feasible. So far, however, we have not seen the cost of electricity produced by atomic energy matching that produced by conventional means, and I am of the opinion that it may be a matter of another twenty or thirty years before we do.

A MEMBER OF THE AUDIENCE: Would the speaker care to tell us about the rôle of secondary aluminium?

THE LECTURER: Not all the audience may be familiar with the two types of aluminium. They are generally referred to in the trade as primary or virgin aluminium (that which is produced direct from the ore), and secondary aluminium (which is produced from scrap). The scrap has of course already been manufactured.

Secondary aluminium is a very important industry. In this country it is of the order of 120,000 tons production last year, and in the United States of about 330,000 tons. It is principally used for making casting ingots. The scrap is segregated at the point of origin and transported to the smelting point where, with the addition of a certain amount of virgin aluminium, it is retransformed into ingots to British Standards specifications, and can be and is used in aircraft and for all other purposes. It is a most important product.

MR. C. ALAN PARKER (S. Herts. College of Further Education): May I make reference to developments in South-West France? In a press report I read that in South-West France developments have taken place for the use of considerable reserves of natural gas which have been discovered there in the process of prospecting for oil. The report which I read seemed to suggest that the gas was to be used for the generation of electricity for aluminium smelting. In view of what has been said about new thermal processes, it would appear that the gas could alternatively be used for the production of heat for this purpose. This would obviously influence the geography of aluminium production, as would also changes in transport costs. I wonder if aluminium production in France is already beginning to show some signs of movement away from the hydro-power sources of the Alps to the new natural gas reserves of the South-West?

This is a very long preamble to a short question. Would the speaker be prepared to comment on the implications of a closer relationship between the aluminium industry and the interests in oil and natural gas?

THE LECTURER: I know of no connection whatever between the aluminium producers and the oil industry, except that whatever is wasted at the moment may be used to advantage when aluminium smelting capacity has been established to produce cheap electricity. As to the method in the South of France to which you refer, I can assure you that there is no special connection between the usage of natural gas there and the new methods of producing aluminium. The new methods of producing aluminium are really in their infancy. After all, it is only a six to eight thousand ton unit now being built in Canada, which will not be ready until next year to prove what is now thought to have been established in the laboratory and pilot plant.

The producers in the South of France are using the natural gas to produce cheaply electricity, while normal methods are used for the production of aluminium. Exacter the same sort of thing is talked of in Kuwait.

MRS. HOWARD CUSWORTH: I was very interested in the lecturer's reference to British Standards specification. Would Mr. Brining tell me whether the pots and pans that we housewives buy are of British Standards specification?

THE LECTURER: I can assure you that the aluminium of which I have been speaking is produced to specification. What the manufacturer does afterwards is outside my control.

MR. J. C. BAILEY: Some years ago I was Chairman of the British Standards Institution Committee which produced a specification for cast saucepans made of aluminium. Some thought was also given to the production of Standard for the visual wrought aluminium holloware, but this was not pursued. However, all the material which is used at present for making aluminium holloware in this country is to British Standards Institution specification.

MR. SMITH BRACEWELL (Mineral Resources Division, Overseas Geological Surveys): One speaker has asked about reports of the construction of an aluminium production plant in Jamaica, and it has occurred to me that the reports he referred to are the ones relating to the construction of a plant in Jamaica to manufacture corrugated aluminium sheet from imported aluminium. (*Financial Times*, 8th September, 1960.) A similar plant was to be built in Trinidad. So far as I know there is no proposal to erect an aluminium reduction plant in Jamaica, as electric power potentialities there are somewhat limited.

THE CHAIRMAN: Thank you for that information. If we have exhausted the questions, I should like to say a few words and thank Mr. Brining for this very interesting lecture. I am pretty amazed about this because Mr. Brining is really an accountant; and he has managed so successfully not to blind us with a lot of figures that I think we should all be very grateful to him!

If I could very briefly take up the question of power from atomic energy: I am sure it will be a long time before atomic energy power will be sold or be available at the rate of ·17 pence per kilowatt hour, which is the figure given by Mr. Brining in his lecture. I thought I might just give you my opinion on that. Now I wish, on your behalf, to thank Mr. Brining for his very illuminating lecture.

The vote of thanks to the Lecturer was carried with acclamation and, another having been accorded to the Chairman upon the proposal of Sir Hilary Blood (Chairman, Commonwealth Section Committee), the meeting then ended.

GENERAL NOTES

THE EDINBURGH FESTIVAL

Opening with auspicious advance bookings in fine August weather, the fifteenth annual Edinburgh Festival reflected, in the event, every credit on its new artistic director, Lord Harewood. 'If there is one thing', he justly observed, 'more exciting than making a 'new' discovery—that is to say bringing something fresh and relevant into one's life—it is finding something new in what had seemed familiar to the point when all novelty is exhausted.' Leaving aside the musical and dramatic offerings, it had certainly appeared to London critics of art that no startlingly fresh experience was likely to be wrung from Jacob Epstein's sculptures, or from Henry Moore's, or again from the acknowledged masters of French painting from Ingres to Picasso at the Scottish Academy. But the stimulus of a change of setting enhanced by the more active, volatile light of the north, together with resourceful presentation, can

in truth yield 'something new in what had seemed familiar', as we discovered once again at the Festival.

It was not Edinburgh's skies, however, but Lord Primrose's clever adjustment of lighting beneath the roof of the Waverley Market, transformed by grey hangings into a maze of twenty-four lofty partitions, which reinforced the drama of Epstein's monumental carvings and his searching portrait bronzes of a lifetime, presented with accustomed flair by Mr. Richard Buckle. 'There is a flame in him', wrote a fine journalist once of Dean Inge, 'and he does not measure life by the things that perish'. The words might have been uttered with equal truth about our profound humanist sculptor, moved most deeply by the mystery of new life stirring in Genesis, and the primitive virility of Adam, by the seeming death of Lazarus and the promise of resurrection exemplified by the Saviour. The strong racial and sensuous strains, essential ingredients of Epstein's motive power, were as clearly manifest throughout this greatest of his memorial exhibitions as was his spiritual exaltation attested in his most powerful images produced over sixty years until the end in 1959. At times, indeed, an ebullient impulse would seem unchecked by a self-critical faculty; or again, his inspiration might flag. For a sculptor who put out sensory antennae and whose vital bronze portraiture depended so much on the reciprocation of his sitter, he was probably unwise to attempt a posthumous interpretation of Smuts, and certainly of Lloyd George. But the lapses count as nothing beside Epstein's achievement. In Edinburgh we had the unique opportunity of seeing all his monumental carvings logically arranged, isolated and spotlit, or photographed whenever they could not be removed from buildings. Most memorable were the souvenirs of the grandest scheme of sculptured adornment ever realized on a London house, whose mutilated fragments in the Strand remain as a standing reproach of the years of denigration and vandalism.

Little need now be said of the seventy-eight masterpieces of French painting chosen by Mr. Douglas Cooper from the late Emil Bührle's extensive collection which were admirably shown at the Scottish Academy, and will be seen at the National Gallery in London from 29th September. Bührle's artistic taste had been cultivated as a student under the art historian Wilhelm Vöge. His material success in heavy industry allowed the collector to gratify his greatest ambition. Increasing prosperity derived from armaments manufacture enabled Bührle to make bids for the genius of French painting far more successfully than did Undershaft for the soul of the Salvation Army. A shrewd rather than adventurous collector, he was drawn especially to superfine quality and the characteristic traits of the Impressionist and Post-Impressionist masters. The exhibition, which begins with the silky immaculacy and candour of Ingres' portrait of an Imperial bureaucrat and closes on the vibrant notes of the *fauve* Braque and Derain, includes a grand array of Cézanne's portraits, no less than seven Van Goghs, and one of Monet's great fluctuating visions of *Waterlilies at Midday*.

A token representation of the Scottish Academy's own work offered an opportunity to judge an interesting cross-section of Northern achievement such as we have not enjoyed in London for years. Painters as distinguished as William MacTaggart and W. G. Gillies unfortunately remain less known to Londoners than Anne Redpath, Joan Eardley, or Robin Philipson, who in recent years have shown to Mayfair gallery-goers the quality of imaginative talent north of the Border. With characteristic hospitality the northern Academy honoured a southern guest, Ralph Brown, whose well-known bronze group of brutish porters heaving a carcase reveals something of Rodin's muscularity without his lofty aspiration. It is rather in extreme refinement of sensibilities finding expression in academic sculpture that Edinburgh's own creators in bronze have made their mark. Eloquence unsmothered by the necessary elaboration of historic detail, exactly related to the massive volumes, characterizes Pilkington Jackson's bronze study of the *Bruce at Bannockburn*, which it is expected

will impressively command on horseback the field of his victory. Another bronze as sensitive in its smaller scale in the sculpture hall was Eric Schilsky's early bust of *Herbert Marks*.

Beautifully seen in the Academy, Robin Philipson reappeared at the Scottish Gallery in Castle Street with his latest paintings of cathedrals and rose windows, his anguished cock-fights and occasional little nude and troubadour. For the best Scottish painters, the potency of the image is still the end-product of expressive handling and paint quality which are usually considered an end in themselves by 'international' stylists to-day. Mr. Philipson's compelling images of peace and conflict are realized often with a freedom of handling as much in tune with our abstract day as with the artist's romantic nature and his orchestration of singing colours and darks.

Elsewhere one realized again that Edinburgh understands better than London the virtue of an elegant L-shaped gallery, not revealing everything from the door but holding its surprise round the corner. So proportioned is the new Commonwealth Institute Gallery in Rutland Square, which well showed off the fragmented river scenes of William Culbert, a Royal College alumnus who has given his energetic extension to the facet forms of Cubism. So shaped too is the Arts Council's Gallery in Rothesay Terrace whose Festival exhibition of Gothic tapestries from the Burrell Collection was, alas, the last one mounted by the late Ellen Kemp, the Council's tired yet untiring northern crusader who had in every sense a 'heart'. It was sad to miss this familiar figure at her favourite rendezvous, the Arts Council's outdoor arrangement of contemporary British sculpture disposed on the lawn before the grey stone belvedere housing Modern Art in the midst of the Botanic Garden. Within the house, which had drawn 132,000 visitors during the year since the previous August when it opened as the Nation's Modern Art Gallery, Sir Kenneth Clark's collection of Henry Moore's small sculpture and drawings was the Festival attraction. The scale is intimate, yet the figures remain as impersonal as earth's timeless crust. Wary and uneasy, they sometimes hover on the borderland of surrealism in featureless deserts. Perpetually mysterious are those Shelter sketch-book leaves of 1940-41, the swaddled cave-dwellers interpreted with an intensity not far removed from the apocalyptic spirit of Blake.

NEVILE WALLIS

MODERN METHODS OF TRAFFIC CONTROL

Until 1st October, a small exhibition illustrating 'Modern Methods of Traffic Control' is on view at the Science Museum in South Kensington. Arranged by the Westinghouse Brake and Signal Company Ltd., it shows, by means of actual equipment and working models, a few of the types of device employed in controlling safely the more rapid flow of traffic on road and rail. Particular attention is paid to those regions of British Railways undergoing electrification.

Admission is free, and the exhibition is open from 10 a.m. to 6 p.m. on weekdays, and from 2.30 to 6 p.m. on Sundays.

OBITUARY

We record with regret the deaths of the following Fellows of the Society.

MR. JOHN INNES

Mr. John Innes, C.B., Managing Director of Cable and Wireless from 1947 to 1950, died in London on 16th August, aged 72. His career in telecommunications began in 1913 when he joined the Post Office engineering department. From 1929–30 he was seconded to the South African Government as adviser on automatic telephone systems. He was appointed assistant engineer-in-chief at the Post Office in 1935, and

in the following year left the technical development side for the administrative post of Assistant Secretary, rising to be Chief Assistant Secretary in 1939. During the early part of the last war, Innes served as Director of Telecommunications. In 1942 he was made C.B. and joined the Ministry of Fuel and Power as Director of Services, becoming Deputy Secretary of the Ministry in 1945. Two years later, on his retirement, he was put in charge of the affairs of Cable and Wireless. From 1950–59 he was a Director of the Telegraph Construction & Maintenance Co.

Mr. Innes was elected a Fellow of the Society in 1950.

SIR CYRIL JONES

Lieutenant-Colonel Sir Cyril Vivian Jones, C.B.E., who died on 2nd September, aged 79, had been Vice-President of the Federation of British Industries since 1955. During the First World War he served with distinction in the R.A.S.C., being made C.B.E. in 1919. He was a Director of the Eagle Star Insurance Co. Ltd. (Kent Board), and for two years (1944–6) President of the Food Manufacturers' Federation. He received a knighthood in 1947. In 1950 he was appointed a Member of the Government Industrial Mission to Pakistan. He became a Fellow of the Society in 1933.

MR. EERO SAARINEN

Mr. Eero Saarinen, one of the leading architects in the United States, died in Michigan on 1st September, aged 51. Born in Finland, he was the son of the celebrated Finnish architect, Eliel Saarinen who took his family to settle in the United States in 1923. Eero Saarinen graduated from Yale University in 1934 and became an American citizen in 1940. Among his major works are the General Motors Technical Centre at Warren, Michigan, the Trans World Airlines terminal at Idlewild Airport, New York, and the recently completed American Embassy building in Grosvenor Square, London. He was a Fellow of the American Institute of Architects, from which body he received several awards of honour. He became a Benjamin Franklin Fellow of this Society in 1960.

NOTES ON BOOKS

DECORATIVE ART. 1961–62. *Edited by Terence Davis. London, The Studio,* 1961. 45*s net*

In a review as brief as this, of a book which appears year after year, how difficult it is to spot progress. I have been attuned through a long and varied experience of the design world to 'feeling' the trend, but I confess I find it difficult to find the wood amongst the trees this time.

Let me start by agreeing with Shirley Conran in her interview with the Editor, when she points out that the prevailing influence in design comes at present from Finland. Finnish design has a sincerity, quality and depth of feeling entirely missing from the other Scandinavians, perhaps because they have perfected, mechanized and commercialized their skills to a far greater degree than their Arctic neighbour. There is, however, still the occasional flowering of the Swedish design tree, which has indeed seemed to fossilize in the last few years. The Finnish influence shows itself in the design of rugs particularly, and I notice it in British Peter Collingwood's handwoven product, the colours slightly sweetened by the sentimentality our English eyes demand. There is the Swedish reversion to the Victorian chaise-longue, by Kersten Horlin-Holmquist (p. 52), a rather desperate modernization of an old theme. There is the carefully culled Swedish shape produced by R. Stennet-Wilson as a design for British glass; and there are many strange and wonderful chairs, a feat of design which seems to be called forth to-day by what was for many years an accepted form,

but which has now become a challenge to the designer's ingenuity and to modern techniques. Fibre glass, foam rubber, steel and plastics compete now with the wood and upholstery of yore. Chairs indeed seem to have become a gimmick. Alternatively, on p. 56, we have the innumerable heights and types of flat platforms, on which are placed foam rubber cushions. Hence your tables become seats designed in 'interchangeable modulus' units, an affair of proportions and jargon, which perform a kind of musical chairs by Robin Day for Hille Ltd. On p. 71 well coloured and textured carpets rub shoulders with patterns which seem to me to smack of the classroom—these all from the United Kingdom. Here and there a little light humour gives us a lift, in bird or animal forms created by craftsmen in clay or glass, a rest for the eye from the impersonal mechanics of much of the furniture.

Then suddenly one's eye is caught by the perfect proportions of a glass bowl from the Vetri D'Arte (Italy, p. 133) and the reintroduction of an old friend, Austria, with a beautiful jug form by Rudolf Trawoger, and one feels that perhaps here is a real expression of our age, akin to the jet plane and the stream-lined civilization of which we are willy-nilly a part.

And as always this book is beautifully produced, a credit both to the publishers and to the photographers who can turn a knotted pile carpet into a ploughed field, while giving it at the same time 'the million dollar look'.

SYLVIA POLLAK

VICTORIAN COMFORT. *A Social History of Design*, 1830–1900. *By John Gloag. London, Black*, 1961, 50*s net*

No single book could be expected to detail the whole conglomeration of tastes and aspirations, the technical achievements and social developments that would comprise a social history of Victorian design. This would be beyond even such an experienced writer and commentator as Mr. John Gloag in a book of 252 quarto pages, packed with some 170 quotations and 270 fully-captioned line drawings, a coloured frontispiece from Frith's 1863 painting of Paddington Station and 16 plates of photographs. Mr. Gloag has restricted himself, therefore, to a narrower view. *Victorian Comfort* can have little to say about fashion, where at almost every level comfort was utterly dominated by attempts at elegance, nor with the slums that in every city 'darkened life and destroyed any hope for thousands of people'. The book barely recognizes the servant problem save in the development of coal vessels designed for the living rooms. It briefly acknowledges the consciences robbed of comfort by the appalling factory conditions where industrialists 'made greed seem respectable by calling it enlightened self-interest', and by the gin temples depicted with Cruikshank's stinging fury.

So many were the comfort-promoting achievements and social changes initiated early in the nineteenth century, however, that any of the nine chapters could well be expanded into a book. The illustrations make a rich contribution to nearly every page, including familiar excerpts from Loudon, Eastlake and the like but also many from such shrewd commentators as *Punch*'s Du Maurier, 'uncovering successive layers of social pretentiousness'. Unfortunately, in a somewhat confusing survey of Victorian furniture, the emphasis on comfort prevents much appraisal of the Victorian's pleasure in fine craftsmanship.

The descriptions of travel are particularly fascinating. Mr. Gloag reminds his readers that coach journeying was at its best for as little as sixteen years—say 1825 to 1841—yet left a permanent mark on the national imagination, becoming identified with the good old times. He writes of the trams once enjoyed in Birkenhead in 1860 before any other town in Europe, and of the virtually forgotten electrically-propelled broughams and victorias of the '90s. Cabs for railway engine drivers only became general in the 1860s, but Mr. Gloag's account shows that many passengers fared

little better. Even after the '70s few British railway carriages were heated; gas lighting continued to Edwardian days; corridor trains date only from 1892. Nearly all the owners and representatives of management 'exhibited an arrogant complacency', but their trains achieved remarkable timing and attained speeds no other country could match. Only Sir James Allport understood public relations, making the Midland's third-class carriages the finest in the world and conveying his passengers in comfort for a penny a mile.

In several chapters Mr. Gloag gives considerable space to comparable American achievements, finding much to applaud, from Pullman cars to electric lighting—discouraged in England by ill-considered legislation until 1888—and even the London slum-clearance of the philanthropist George Peabody. Basically, however, the Victorians' activities appear to intrigue the author rather than their possessions. He details especially the institution of the annual seaside holiday; the metamorphosis of Christmas into a boisterous commercialized spree; the increase in outdoor activity due to the safety bicycle; the introduction of cigarette smoking; the extension of reading, including cheap advertisement-laden newspapers and magazines; the class grouping in public houses with their public, private and saloon bars; the delight in music halls. Never, it seems, was the Victorian permitted the comfort of idleness. In a book that largely suggests an ugly, acquisitive, pretentious society, each class defensively protecting its hard-won status, with a passion for respectability only sometimes expressed in bodily ease, there is a hint of nostalgia in the conclusion: 'For the middle classes and the rich it was a happy age'.

THERLE HUGHES

KUNIYOSHI. *By B. W. Robinson. London, H.M. Stationery Office,* 1961. *27s 6d net*

Mr. B. W. Robinson, who arranged the recent exhibition at the Victoria & Albert Museum of its collection of prints and drawings by Kuniyoshi, presents here a biographical sketch and critical estimate of this Japanese artist of the Ukiyoye school. In Stewart's massive *Subjects portrayed in Japanese colour prints* the names of no less than 186 Ukiyoye artists are listed. Of these the best known in the West have been Hokusai and Hiroshige. The others are hardly more than names, though a few, like Utamaro and Shiraku, have been the subjects of individual studies in England. Until the present volume, however, no book has been devoted to Kuniyoshi alone.

Kuniyoshi, the centenary of whose death occurs this year, was the last master of the Ukiyoye school. This school is an interesting phenomenon, with no close parallel in Europe. Eighteenth-nineteenth-century Japan was still feudal, but a rich bourgeoisie had made its appearance and wanted a more popular form of picture than that usually favoured in aristocratic circles. The demand was for pictures of stage life and personalities, of scenes from the dramas most frequented, the amusements of Tokyo night-life, and the picturesque views in the neighbourhood of the capital and along the main roads leading to it. Artists appeared to supply the demand. A picture was put on the market, the colour print, a development of the Chinese technique with wooden blocks. Though these prints were cheap, plain in meaning and intended to please ordinary people, they were remarkable for the high level of their accomplishment. The drawing was vigorous, the composition elaborate and the colour delightful.

Kuniyoshi lived towards the close of the period which had seen the production of tens of thousands of such prints. He was not a great original artist like Hokusai, nor had he Hiroshige's lyrical mood, but inside the contemporary style he showed immense vigour as a draughtsman and ingenuity in composition. Like all the later artists of the school, his colour was defective when, as often happened, he allowed aniline dyes imported from Europe to be used to print his work instead of the

vegetable colours of his predecessors. His designs, too, were sometimes overcrowded and had not the impact of the greatest masters.

His speciality was depictions of striking scenes from history, legend, the drama and folklore, wherein heroes, fighting men, ghosts and monsters surge and grapple. In the hurly-burly of battle or where men were at grips with apparitions, he had no equal in the school. He is the most romantic of its artists.

It was his very excellence in this particular vein which has prevented him from gaining here the popularity won by Hokusai and Hiroshige, who can be enjoyed by us without any special knowledge of Japanese history or literature. Fully to appreciate Kuniyoshi one should have what the Japanese had who bought his pictures—a close acquaintance with their subjects. We will readily admit the masterly composition of his *The Soga brothers' last fight*, the extraordinary fancy of *Raiko tormented by the Earth-Spider*, or of *The Taira ghosts attacking Yoshitune's ship*, and the wild splendour of the arrow piece, *The last stand of Kusunoki at Shijo-nawate*—all four triptyches of superlative quality—but they do not move us as they would those who knew what they were about.

H.M. Stationery Office is to be congratulated on the way the book is produced. The 98 monochrome plates are clear. Mr. Robinson's 70 pages of letterpress are learned and careful, his catalogue detailed and his appendices on publishers and seals important for the student.

MAURICE COLLIS

LIBRARY ADDITIONS

Fellows and Associates are reminded that they may borrow up to five books at a time from the Library and retain them for a month. Members living outside London may borrow books by post. Books sent by post are despatched at the cost of the Society and returned at the cost of the borrower. Books marked with an asterisk are part of the reference library, and not normally available for loan.

LIBRARIES, MUSEUMS AND SOCIETIES

*LONDON UNIVERSITY. SCHOOL OF LIBRARIANSHIP AND ARCHIVES—

Cumulated list of bibliographies and theses accepted for Part 2 of the University of London Diplomas in Librarianship and Archives in the post-war years 1946–1960. *London, London University School of Librarianship & Archives*, 1961. (Occasional publication—No. 10.) Presented by the publishers.

*NEW YORK STATE LIBRARY, ALBANY—The Gotshall Collection in the New York State Library. *Albany (N.Y.), New York State Library*, 1960. Presented by the publishers.

*OXFORD UNIVERSITY, BODLEIAN LIBRARY—The large scale county maps of the British Isles, 1596–1850: a union list; compiled in the map section of the Bodleian Library by Elizabeth M. Rodger. *Oxford, Bodleian Library*, 1960. Presented by the publishers.

EXHIBITIONS

ALLAN, DOUGLAS ALEXANDER—'Exhibitions era from war to peace': seventeen years of temporary exhibitions at the Royal Scottish Museum. *Edinburgh, Royal Scottish Museum*, 1961. Presented by the author.

ARTS COUNCIL OF GREAT BRITAIN—An exhibition of national art treasures of Korea, lent by the government of the Republic of Korea, Victoria & Albert Museum, 23 March to 7 May; [catalogue] *London, Arts Council*, 1961.

ARTS COUNCIL OF GREAT BRITAIN—Morris and Company: 1861–1940: a commemorative centenary exhibition. *London, Arts Council of Great Britain*, 1961.

SCIENCE

*MUSSON, A. E., *and* ROBINSON, E.—'Science and Industry in the late eighteenth century'. Reprinted from *The Economic History Review*, 2nd Series, Vol. XIII, No. 2. 1960. Presented by the authors.

ENGINEERING, TRADE AND INDUSTRY

MCCULLOCH, JOHN RAMSAY—A Dictionary, practical, theoretical, and historical, of commerce and commercial navigation. *2nd Edition. London, Longman*, 1841. Presented by the Royal Agricultural Society.

MUSPRATT, SHERIDAN—Chemistry, theoretical, practical and analytical; as applied and relating to the arts and manufactures. *Glasgow, William Mackenzie*, 1860. Presented by Douglas White.

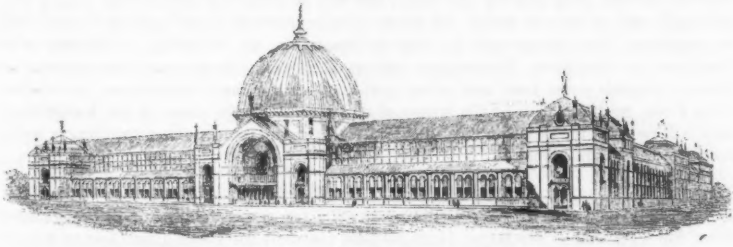
INDUSTRIAL AND COMMERCIAL ART AND DESIGN

ANDERTON, BASIL—Thomas Bewick, the Tyneside engraver. *Newcastle upon Tyne, Mawson Swan & Morgan*, 1928.

FROM THE JOURNAL OF 1861

VOLUME IX. *11th October*

BUILDINGS FOR THE INTERNATIONAL EXHIBITION OF 1862



'Front of the building for works of industry in Prince Albert's-road'

The following description of the Buildings is abridged from a pamphlet recently published:

THE SITE

of the principal portion of the buildings adjoins the Royal Horticultural Gardens at South Kensington. It lies between Prince Albert's-road on the west, Exhibition-road on the east, and Cromwell-road on the south. The ground belongs to the Commissioners for the Exhibition of 1851, and was purchased by them out of the surplus funds of that Exhibition.

THE CHARACTER OF THE STRUCTURES,

unlike the uniform glass building in 1851, is varied, the different purposes for which the buildings are destined having been kept in view in designing them by their engineer and architect, Captain Fowke, R.E. The buildings provide on a large scale for four objects; I. *Picture Galleries*, which require to be solid structures, secure from all accidents of weather, extremely well ventilated, and lighted at the top; II. Ample spaces of different forms, and lighted in different ways, for the *Exhibition of Works of Industry*, arranged in courts and galleries; III. Platforms and wide passages, for *Ceremonials and Processions*; and, IV. Accommodation for *Refreshments*.

THE PICTURE GALLERIES

occupy three sides of a quadrangle. The largest gallery is in Cromwell-road; this is 1,150 feet long, 50 feet wide, and 50 feet high above the ground floor; being about as long as the Gallery at the Louvre at Paris. . . .

THE INDUSTRIAL BUILDINGS

will be constructed chiefly of iron, timber, and glass. They consist of . . . two duodecagonal domes which are 160 feet in diameter and 250 feet high, and are the largest of ancient and modern times. . . . The domes will be of glass, with an outer and inner gallery. It has been proposed to erect one of Messrs. Chance's dioptric lights at the top of one of them and to illuminate it at night. The vista from dome to dome, through the nave, is 1,070 feet. Each of the domes springs from the intersections of the nave with the two transepts. The nave and transepts are 100 feet high and 85 feet wide; the nave is 800 feet long, and the transepts are each about 635 feet long, including the domes. They are lighted on both sides by clerestory windows upwards of 25 feet high, and would reach a mile if extended. . . . At 25 feet from the ground a gallery runs at each side of the nave and transepts. . . .

THE REFRESHMENT HALLS AND ARCADES

will be permanent buildings, and will present novel and striking features. They overlook, with a north aspect, the whole of the Royal Horticultural Gardens, with its cascades, fountains, &c. They will be cool, but with a sunny view. The halls will be 300 feet long and 75 feet wide; the two arcades will have about 15,000 feet in length and 25 feet in width. All kinds of refreshments, both light and solid, will be supplied. The visitor will be able to obtain, in the morning, a *déjeuner à la fourchette*; at luncheon, Neapolitan ices or Bass's ale, and bread and cheese; at dinner, English roast beef and plum pudding, or the latest inventions in cookery from Paris, with samples of the wines of all nations. At the close of the Exhibition, they will become the most delightful dining-halls in the metropolis, supplying a great public want in this respect.

THE MACHINERY GALLERIES

are the only portions which are obviously of a temporary character. They extend along the west side of the Royal Horticultural Gardens for about 1,000 feet in length by 200 feet wide, in four spans of 50 feet wide each. They are constructed of timber, most ingeniously contrived by Captain Fowke for strength, lightness, and cheapness, and offer a very useful suggestion for the cheapest kind of agricultural buildings. These are all of framed work, without any joinery. . . .

THE CONTRACT

for the whole works has been let to Messrs. Kelk and Charles and Thomas Lucas, Brothers, whose tender was the lowest. These two large firms have become partners for this work. . . . The contract is of a threefold character: for the use and waste of the buildings a sum of £200,000 is to be paid absolutely; if the receipts exceed £400,000, then the contractors are to take up to a further sum of £100,000; and if this sum is fully paid, then the centre acre of the great Picture Galleries is to be left as the property of the Society of Arts. Lastly, the contractors are bound to sell absolutely the remaining rights over the buildings for the further sum of £130,000, which may possibly be paid by the surplus receipts of the Exhibition, if the success be great, of which there is a good prospect.

Whether or not there shall be a surplus depends in great measure on the management. If there be a deficit, the Guarantors, who have liberally taken upon themselves the risk, must provide for it. If there be a surplus, the Guarantors will direct the destination of it.